Time & Location: May 20, 2015 at 10:00 AM in Engineering Building II 180
Title: A MACRO-LEVEL SUSTAINABILITY ASSESSMENT FRAMEWORK FOR OPTIMAL DISTRIBUTION OF ALTERNATIVE PASSENGER VEHICLES

Sustainable transportation and mobility are key components and central of sustainable development. Considering that the sustainability concept encompasses issues related to economy, environment, and society, the sustainability research should cover all of these dimensions and the trade-off relationships between them. In this regard, this research aims to fill important knowledge gaps in the literature that can be classified as application-based and mythological contributions. Methodologically, this research aims to advance an existing sustainability assessment framework, known as the Life Cycle Sustainability Assessment by integration of input-output analysis and multi-criteria decision making to quantify and analyze the trade-off relationships between triple bottom line impacts. Application based contribution of this work is to reveal the macro-level social, economic, and environmental impacts of alternative vehicle technologies and to estimate the optimum passenger vehicle mix in the U.S. The studied vehicle technologies are conventional gasoline, hybrid, plug-in hybrid with four different all-electric ranges (10, 20, 30, 40), and full battery electric vehicles. In total, 16 macro level sustainability indicators are quantified for two different scenarios: a scenario in which electric vehicles are charged through the existing U.S. power grid with no additional infrastructure (Scenario 1) and an extreme scenario in which electric vehicles are fully charged with solar charging stations (Scenario 2). The analysis covers all life cycle phases from the material extraction, processing, manufacturing, and operation phases to the end-of-life phases of vehicles and batteries. Results of this analysis revealed that the manufacturing phase is one of the most influential phases in the terms of socio-economic impacts compared to other life cycle phases, whereas operation phase is the most dominant phase in environmental impacts. Scenario 2 improves the sustainability performance of the plug-in and battery electric vehicles in majority of the indicators. In a balanced weighting case in Scenario 1, where the environmental and socio-economic indicators have equal importance, hybrid electric vehicles have the highest distribution with 91% of the U.S. passenger vehicle fleet, whereas when the socio-economic indicators matters only, 99.5% of the distribution is composed of conventional gasoline vehicles. In a balanced weighting case in Scenario 2, Plug-in hybrid with 10 miles of all-electric range constitutes the 100% of the U.S. passenger vehicle fleet. Optimum vehicle distribution results showed that the current state of the U.S.’s power generation infrastructure does not support the widespread adoption of PHEVs and BEVs.

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Approved for distribution by Qipeng Zheng, Committee Chair, on May 20, 2015.

The public is welcome to attend.