A Comparison on Fuel Economy and Emissions for Conventional Hybrid Electric Vehicles and the UTS Plug-in Hybrid Electric Vehicle

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***Abstract*—This paper covers a comparative study on fuel economy and emissions of a conventional hybrid electric vehicle (HEV) and the UTS plug-in HEV (PHEV). The interaction between the components such as energy storage system, electric machine, power control unit and internal combustion engine of the UTS PHEV are complex in order to optimize the fuel economy and emissions brought by the vehicle. In this work, the model of the UTS PHEV is derived and implemented numerically in the MATLAB/SIMULINK environment to study its operational performance in various drive cycles measured under life conditions. The simulation results in terms of fuel economy and emissions of the series and parallel HEV from the Advanced Vehicle Simulator and UTS PHEV are compared and the pros and cons discussed.**

Keywords- hybrid electric vehicle; plug-in hybrid electric vehicle; powertrain; energy management strategy; fuel economy; emissions

I. INTRODUCTION

Figures 1-3 show the block diagrams for a series hybrid electric vehicle (HEV), parallel HEV and the proposed UTS plug-in HEV (PHEV). These block diagrams consist of an energy storage system (ESS), a power control unit (PCU), one or two electric machines (EMs) and an internal combustion engine (ICE) [1,2]. The series HEV model contains two separate EMs, which are used as the motor and generator, respectively, and an ESS with no ultracapacitor bank. The proposed UTS PHEV, however, has only one EM which functions as either a motor or generator at a time and in the ESS there is an ultracapacitor bank for fast charging and discharging during the regenerative braking and fast acceleration. The full size of ICE in a parallel HEV is required because when the state of charge (SOC) of the ESS is low, the ICE will move the vehicle alone. The ICE in UTS PHEV can move the vehicle while charging the ESS until the ESS SOC reaches a high level and the EM will take over to move the vehicle. A special energy management strategy (EMS) for the UTS PHEV is needed in order to save the weight, space and cost while improving the fuel economy and emissions.

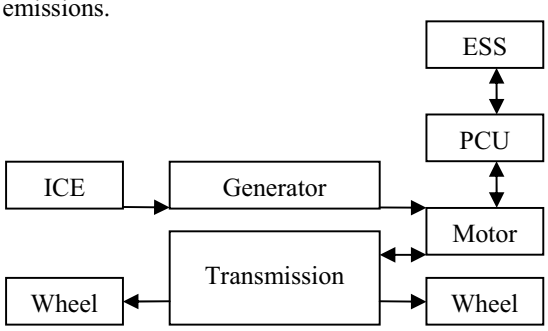

Figure 1. Block diagram of the series HEV configuration

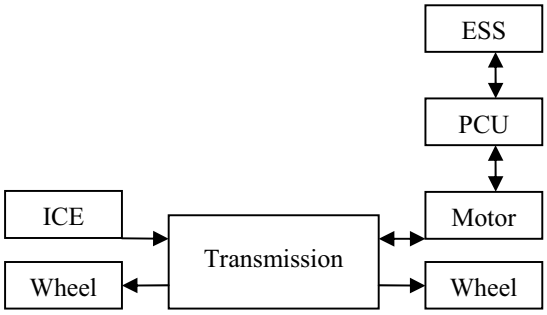

Figure 2. Block diagram of the parallel HEV configuration

978-1-4244-5586-7/10/$26.00 © 2010 IEEE