



Evaluating Emerging Engine and Powertrain Technologies on Globally Popular Vehicle Platforms

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Abstract

This paper examines, for several major markets, the fuel savings achievable with advanced engine technologies as "drop-in" substitutions for existing engines, as well as from increased electric hybridization of the powertrain. Key segments of light duty vehicles in major automotive markets including the US, China, EU, Japan, India, and Saudi Arabia were examined. Representative vehicles for each market were simulated using advanced vehicle modeling tools and evaluated on the relevant local regulatory cycle or cycles. In all cases, to ensure meaningful results, the performance of a given vehicle was maintained as engine and powertrain technology was varied through appropriate resizing of

powertrain components. In total, 4 engine technologies and 5 powertrain architectures were simulated for 5 different markets. Additionally, to understand the potential impact of regional and seasonal variations in ambient temperature, a simple assessment of the impact of increased cabin heating and cooling loads was conducted for a single globally relevant vehicle. Results showed that opportunities exist for improving the drive cycle fuel economy of these mass market vehicles on their relevant regulatory cycle(s) through alternate engine technology and increased levels of powertrain hybridization, with the extent of that benefit dependent upon the vehicle performance requirements and the specific engine and powertrain technology.

Introduction

Study Scope and Approach

To better understand the ability of alternative engine technologies to impact the real-world fuel consumption globally, the prominent vehicle segments in several major markets in the world were examined. These major markets were chosen based upon the combination of their overall size based on data from [1] and the relative vehicle characteristics of their market. These chosen markets are the United States, China, E.U., Japan, India, and Saudi Arabia.

Broadly speaking, in other regions performance expectations tend to be lower and vehicles tend to be smaller than those in the U.S. The extent of these differences vary by market, as will be evident from subsequent parts of the paper. While not among the largest markets, Saudi Arabia is interesting to examine as its vehicles tend to be similar to those in the U.S. in terms of performance requirements, but skewed even more so towards larger vehicles.

To further focus on the realizable opportunity for advanced engines and hybridization, the key passenger car segments in each of the above markets was examined. The segments which constitute the majority of vehicle sales in each market were chosen, based on data from Marklines for 2018 [2]. These segments, along with the percent of the total respective market they represent, are summarized below:

TABLE 1 Key market segments in major global markets examined in this study. Entries in the table indicate that a given segment in that market was examined in this work; values denote market share [%] of each vehicle segment in that region, based on data from Marklines [2] for 2018. See text for further explanation.

Segment	US	China	EU	Japan	India	Saudi Arabia
Pickup	17					11
SUV E						10
D	14	10				24
SUV D	14					
C	12	23	16	9		20
SUV C	21	22	16			
B			18	28	18	
A				28	23	

In [Table 1](#), the presence of a value indicates that the specific segment in that market was examined in the study due to its sales volume in that region; the lack of a value means that segment was not examined for that region in this study because it was not a top-selling segment (and not that the market share of vehicles in that segment was zero for that region). For the U.S., roughly 3/4 of all passenger car sales are represented by the vehicle segments examined here, whereas

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