Transport-SIG SDS Workshop, March 22-23 2018, Vienna

Informing transition strategies to alternative fuel vehicle technologies in developing countries

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Extended Abstract

The market penetration of alternative fuel vehicles is well underway in developed economies, and has been accelerating rapidly in recent years. However, this is not the case in most developing countries where infrastructure challenges pose major obstacles to the introduction of these technologies. This is the case in several countries of the Middle East and North Africa (MENA) region where infrastructure development lags behind the rapidly increasing demand for transportation (M. Haddad, Mansour, & Stephan, 2015). As a result, reliance on conventional fuels and internal combustion engine vehicles is expected to continue in the near future. The region's consumption of energy, mostly oil, in transport has almost doubled between 2000 and 2014 (OECD/IEA, 2016), and forecasts estimate a 1.9% annual increase on average until the year 2040 (U.S. EIA, 2016), almost double the rate for Europe and second only to China (UNEP, 2011). In Lebanon where our research is conducted, the heavily congested road transport sector accounted for over 23% of annual greenhouse gas (GHG) emissions in 2012, in addition to a significant share of air pollutant emissions, making it one of the most unsustainable transport systems in the region (MOE/UNDP/GEF, 2016).

Several system dynamics (SD) studies have developed diffusion and adoption models for alternative fuel vehicle technologies, including incentives for accelerating the spread of a particular technology or the transition to a favorable vehicle mix (Pasaoglu et al., 2016; Struben & Sterman, 2008). However, the majority of studies have focused on industrialized contexts where the backbone infrastructure for alternative fuels, such as natural gas pipelines and clean electricity mix, are readily available. In this work, we build on established SD transition models by considering the context of developing countries where transition to alternative fuel vehicles is highly dependent on the availability of backbone infrastructure, the very limited purchasing power of consumers, and the lack of environmental awareness, among other limiting factors (M. G. Haddad, Mansour, & Afif, 2017).

We develop an SD model to define the most beneficial alternative fuel vehicle mix based on the dynamics of government investment in backbone and refueling infrastructure, and accounting for user preferences and policy enablers for the different vehicle technologies. User adoption is based on choice models using several attributes such as vehicle costs, driving range, emissions savings, word of mouth, and refueling infrastructure availability. The model uses fuel consumption, emissions and cost data developed for the local context (Mansour & Haddad, 2017). The primary output of the model is the sales of alternative fuel vehicles as a result of infrastructure investment and user adoption in a way to minimize related costs for maximum reduction of GHG emissions.

The work is still in progress, the main SD model components will be presented.

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