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Title: Breaking down non-cost barriers to technology adoption is critical for the transport-energy transformation

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Within the context of the EU-FP7 ADVANCE project ("Advanced Model Development and Validation for Improved Analysis of Costs and Impacts of Mitigation Policies"), several integrated assessment (IAM) and energy-economic (E4) modeling teams are at present developing an approach to better represent consumer heterogeneity/behavior and non-cost barriers to technology adoption in their models. The aim is to incorporate utility-based consumer choice decisions in the transport sector, namely the light-duty vehicle mode. IIASA's Energy Program is leading this activity within the research community and, in this capacity and for experimentation purposes, has undertaken the role of the "pioneering modeling team". This has entailed expanding and enriching the end-use detail of the MESSAGE-Transport model (an extension of the standard MESSAGE model), as described below.

IAMs, like MESSAGE, have been widely used as key instruments for developing long-term energy and emission scenarios and to identify cost-effective patterns of resource use and technology deployment over time, particularly in the context of climate change mitigation. Yet, one of the major deficiencies of most current models is their limited representation of heterogeneity and consumer behavior on the demand-side of the energy system. Behavior cannot be ignored, however, when it comes to whole-system modeling, as it is a critical aspect of policy- and decision-makiang. The objective of this project is to develop a bridging approach between detailed vehicle-choice models and more aggregated global IAM-E4 frameworks. More specifically, the MESSAGE approach disaggregates light-duty vehicle demands into a mix of consumer groups and then assigns additional cost terms ('disutility costs') to the vehicle technologies within each of these groups, in order to capture non-cost barriers to alternative fuel vehicle adoption. In one formulation, for instance, consumers are divided up along three separate dimensions, each with three distinct consumer types (for a total of 27 groups): (i) Settlement pattern (Urban / Suburban / Rural); (ii) Attitude toward technology adoption (Early Adopter / Early Majority / Late Majority); (iii) Vehicle usage intensity (Modest Driver / Average Driver / Frequent Driver). Region-specific disutility costs are estimated using the MA3T vehicle-choice model of Oak Ridge National Laboratory. The ultimate goal of the improved behavioral modeling framework is to generate scenarios that are more realistic and, therefore, more policy relevant.

Work on this project is still ongoing, but initial results already lead to several important conclusions. For example, the inclusion of non-cost barriers to technology adoption in the decision-making algorithms of models leads to a considerably slower uptake of advanced vehicles than under normal model assumptions (i.e., when these barriers are not taken into account). In stringent climate policy scenarios, in particular, a shift is seen from electric and hydrogen vehicles back to biofuels and fossil liquids – owing to issues of range anxiety, lack of refueling station availability, risk aversion, and low model availability in the early days of the alternative fuel vehicle market. If these barriers continue to persist over the long term, then climate policy costs may be markedly higher than estimated by current modeling approaches. Policies supporting early-stage recharging/refueling infrastructure can bring down these barriers, while vehicle purchase subsidies can help compensate for them in the early-market phase.