Making Alternative Fuel Vehicles Work for Everyone: Quantifying the Environmental and Equity Potential

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Background and Key Questions
Burning fossil fuels for transportation accounts for more than one-quarter of carbon dioxide (CO₂) emissions in the United States. In addition to fueling climate change, internal combustion engine (ICE) vehicles contribute to urban air quality problems. Portland, Oregon has been a leader in local climate action planning, with aggressive reduction targets (80% less CO₂ by 2050). Hybrid electric and electric vehicles (HEVs and EVs) have the potential to reduce fossil fuel use. However, due to price premiums the benefits of alternative fuel vehicles have accrued disproportionately to higher-income households (Fig 1).

This research asks the following questions:
- How much fuel could a region save by replacing some existing personal use vehicles with HEVs and EVs?
- What are the most effective methods for targeting vehicles to replace?
- Are there coordinated strategies that reduce fuel use and promote equitable access to efficient and clean mobility?

Data and Method
We used a combination of national and local data sources to construct realistic policy scenarios (Fig 2). Each scenario involved replacing a portion of the actual vehicle fleet in the Portland region.

Vehicle Mileage Model
A national model of vehicle-level VMT was estimated in order to predict miles driven before and after policy interventions. We couldn’t use local odometer data directly because it was not available for all vehicles and wasn’t tied to household characteristics (Table 1).

Lower-income households tend to drive the same vehicle considerably fewer miles. As density increases, though, they reduce the driving they do by less than wealthier households.

Policy Scenarios
Each scenario replaced 10% of the current ICE vehicle fleet in the Portland, Oregon region with new HEVs or EVs. To make things more realistic, we assumed 20% of vehicles would be targeted, and half of those would be replaced at random. Scenarios varied by how and where vehicles were targeted for replacement (Figs 3 & 4). We also considered versions of each policy with an explicit equity focus as well as an equity-only scenario that replaced vehicles in lower-income areas.

Results
Estimated fuel savings varied considerably by targeting strategy, ranging from a small increase in use (due to rebound effects) up to nearly 13% savings region-wide (Fig 5). EVs performed better due to greater efficiency and lack of rebound effects.

Conclusions
- Replacing 10% of existing vehicles with HEVs and EVs resulted in reducing regional fuel consumption up to 13%.
- Results varied considerably by how and where vehicles targeted for replacement; high annual mileage vehicles made best targets.
- If vehicle mileage data are not available, low-efficiency vehicles make better targets than older ones. Older vehicles are not always inefficient and are subject to potentially high rebound effects.
- Equity-focused policies led to large shifts in fuel savings to lower-income areas with similar overall efficiency gains. Could also increase mobility.
- This work focused on regional and small area impacts. Future work will seek to consider policy effects at household-level.

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