How Much Do Electric Drive Vehicles Matter to Future U.S. Emissions?

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Motivation
- Increasing concerns regarding anthropogenic climate change and urban air quality
- Current U.S. policies, tax credits, and incentives promote electric drive vehicles (EDVs)
- High uncertainty about the future market penetration of EDVs and their effect on emissions despite the potential benefits over competing vehicles

Electric Drive Vehicles include:

Objectives
- Identify the conditions under which EDVs achieve high market penetration in the U.S. light duty vehicle sector through mid-century
- Quantify the resultant change in CO₂, SO₂, and NOₓ emissions

Approach
Utilize a technology rich energy system model comprised of:

A Model generator (TIMES)
- Energy-economy optimization framework to identify the least-cost way to satisfy end-use demands

Input Data: National U.S. TIMES Dataset (NUSTD)
- Represents the U.S. energy system at the national scale and contains information on fuel prices; technology cost and performance estimates; and end-use demands over the next 40 years
- Transportation sector: light duty vehicles (LDV), heavy duty vehicles (HDV), and off-highway (OH) technologies
- 85 LDVs: 7 vehicle size classes, 6 fuel types, and 13 vehicle types
- EDVs: hybrid, plug-in hybrid (PHEV20 and PHEV60), and electric (BEV160)
- NUSTD is publicly available at [http://www.energy-modeling.org/](http://www.energy-modeling.org/)

Model outputs
- Optimal installed capacity and utilization by technology, equilibrium energy prices, and emissions

Scenarios
Scenario development was focused on five factors likely to affect the cost-effectiveness of EDVs relative to other vehicle technologies:
- Natural gas price
- Crude oil price
- EDV battery cost
- A federal cap on CO₂ emissions
- A federal renewable portfolio standard (RPS)

Results
- Estimated 2050 NOₓ emissions
- Estimated 2050 SO₂ emissions
- Larger bubbles indicate higher oil price
- Assumption 1
  - CO₂ policy, RPS
  - Tech Deployment
  - Emissions
- Assumption 2
  - Diesel Hybrid
  - Diesel
  - Electric
- Assumption 3
  - Diesel
  - Electric

Insights
- High oil prices and low EDV battery costs are the strongest drivers of EDV deployment.
- BEV160s and PHEV60s are the most cost-effective EDVs in the long run.
- EDV deployment produces only a small effect on system-wide CO₂, SO₂, and NOₓ emissions. Why?
  - Overall CO₂ share from the LDV sector is currently 20% of total U.S. CO₂ emissions.
  - EDV charging can still produce comparable emissions to conventional vehicles.
  - Effect of other sectors on emissions is significant.
- CO₂ cap is the strongest driver of lower CO₂, SO₂, and NOₓ emissions.
- EDVs can be a cost-effective option under a CO₂ cap.

Acknowledgement
This material is based upon work supported by the National Science Foundation under Grant No. CBET-0853766.