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Comparison of Vehicle Fuel and CO2 Footprints by Technology Type

Prepared by

Burcu Cigerli

Graduate Fellow, James A Baker III Institute for Public Policy
Graduate Student, Department of Economics
Rice University

and

Kenneth B Medlock III

James A Baker III and Susan G Baker Fellow in Energy and Resource Economics, and
Deputy Director, Energy Forum, James A Baker III Institute for Public Policy
Adjunct Professor, Department of Economics
Rice University

May 15, 2012

James A Baker III Institute for Public Policy
Rice University

Energy Consumption Calculations for Different Vehicle Technologies

- EIA reports light-duty vehicle energy consumption by type of technology in trillion Btu for past and future years. We compare technology choices in 2010 and 2035. We allow technology to improve across the technology types per the assumptions made by the EIA.
- For ease of comparison, we consider fuel use in billion cubic feet per day (bcfd) equivalents across 4 technology options assuming ALL vehicles are one of the four different options:
  - Gasoline Internal Combustion Engine (ICE), Gasoline hybrid, Compressed Natural Gas ICE, and 100 mile Electric vehicle.
    - Gasoline ICE technologies (including hybrid) are reported by EIA in trillion Btu after converting from gallons of fuel consumption using a heat content conversion factor.
    - Compressed Natural Gas ICE fuel use is converted from trillion BTU to bcfd using a heating value of 1.04 mmBTU per mcf.
    - The calculation for fuel use in electric vehicles is outlined below.

Energy Consumption Calculation for Electric Vehicles

- Electric vehicles (EVs) energy consumption per EV for energy source *i* at time *t*, denoted as $e_{i,t}^{EV}$, is calculated as:

$$e_{kWh,2010}^{EV} = \frac{e_{MMBTU,2010}^{EV}}{3412}$$

where 3412 BTU/kWh is the heating value of delivered electricity.

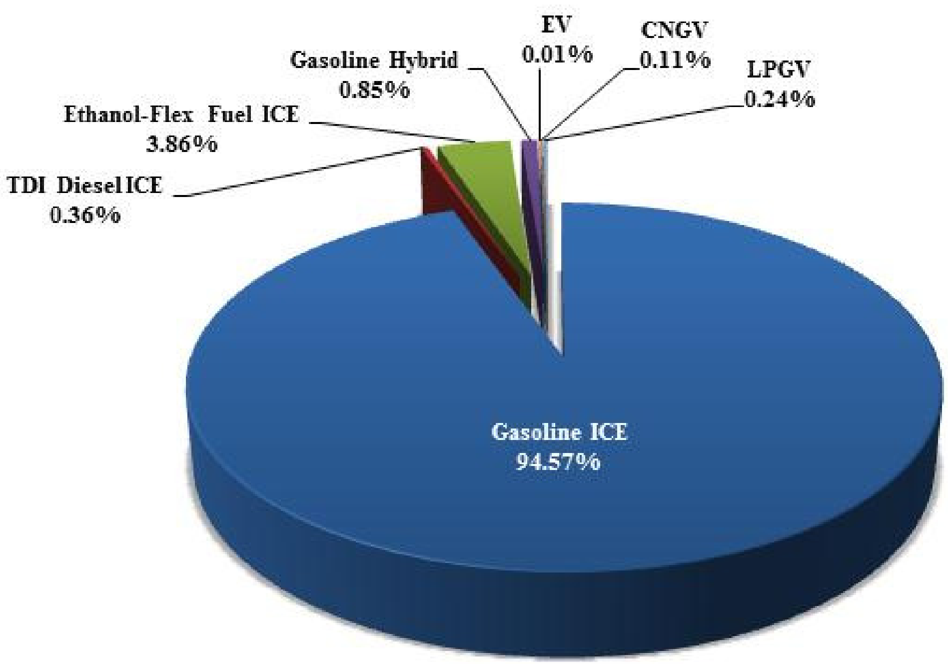
- Next, assume all electricity for the EV fleet is generated by natural gas combined cycle power plants with a heat rate of 7,000 BTU/kWh. We then multiply by the *entire* vehicle stock (denoted as *veh*) to yield the amount of natural gas (in bcfd) required, denoted as $E_{bcfd,t}^{EV}$, to generate enough electricity to power the EV fleet, if the *entire* vehicle stock is EVs:

$$E_{bcfd,2010}^{EV} = \frac{e_{kWh,2010}^{EV} \cdot (7,000/1,000,000) \cdot veh}{365}$$

Note that the HR assumption of 7,000 is equivalent to a thermal efficiency of about 48%. A modern NGCC plant running as base load can achieve thermal efficiency of about 53%, so the assumption compensates for average line losses in transmission.

Light Duty Vehicle Stock Composition, 2010

- The total light duty vehicle stock (cars and trucks) in 2010 was 225 million.
- We use this as the baseline assumption in calculating the fuel use footprint of the vehicle fleet in 2010 if all vehicles were of the same technology type.
- The vehicle stock in 2035 grows to 274 million, an increase of almost 25%.



Total Light Duty Vehicle Stock

2010 = 225 million

Source: EIA AEO 2011

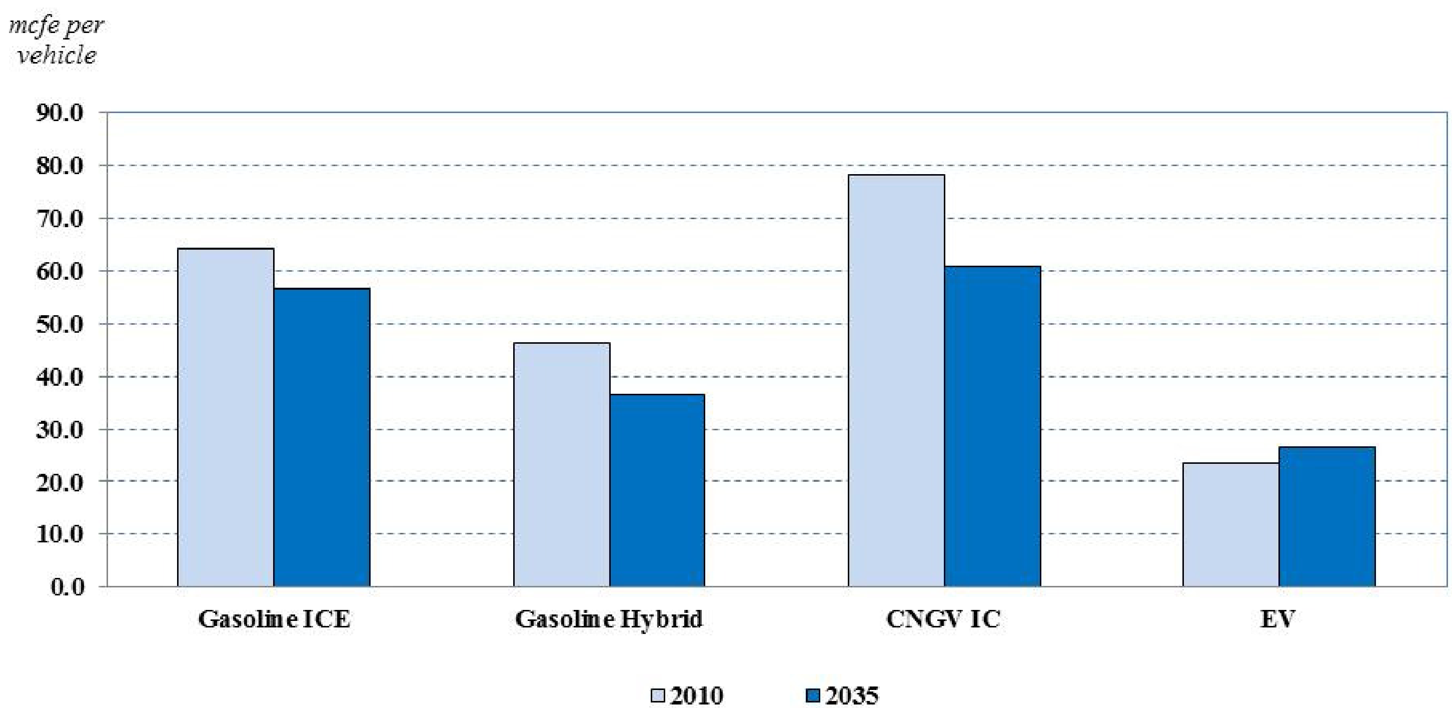
Light Duty Vehicle Stock Fuel Use, 2010

- Gasoline use dominates total light vehicle fuel use in 2010.

Technology Type	Bcf per day (equivalent)	Per day fuel use in technology specific units
Gasoline ICE Vehicles	39.55	331.5 million gallons/day
100 Mile Electric Vehicle	0.001	176.6 thousand kWh/day
Compressed Natural Gas ICE	0.02	0.02 bcf/day
Gasoline Hybrid	0.26	2.03 million gallons/day

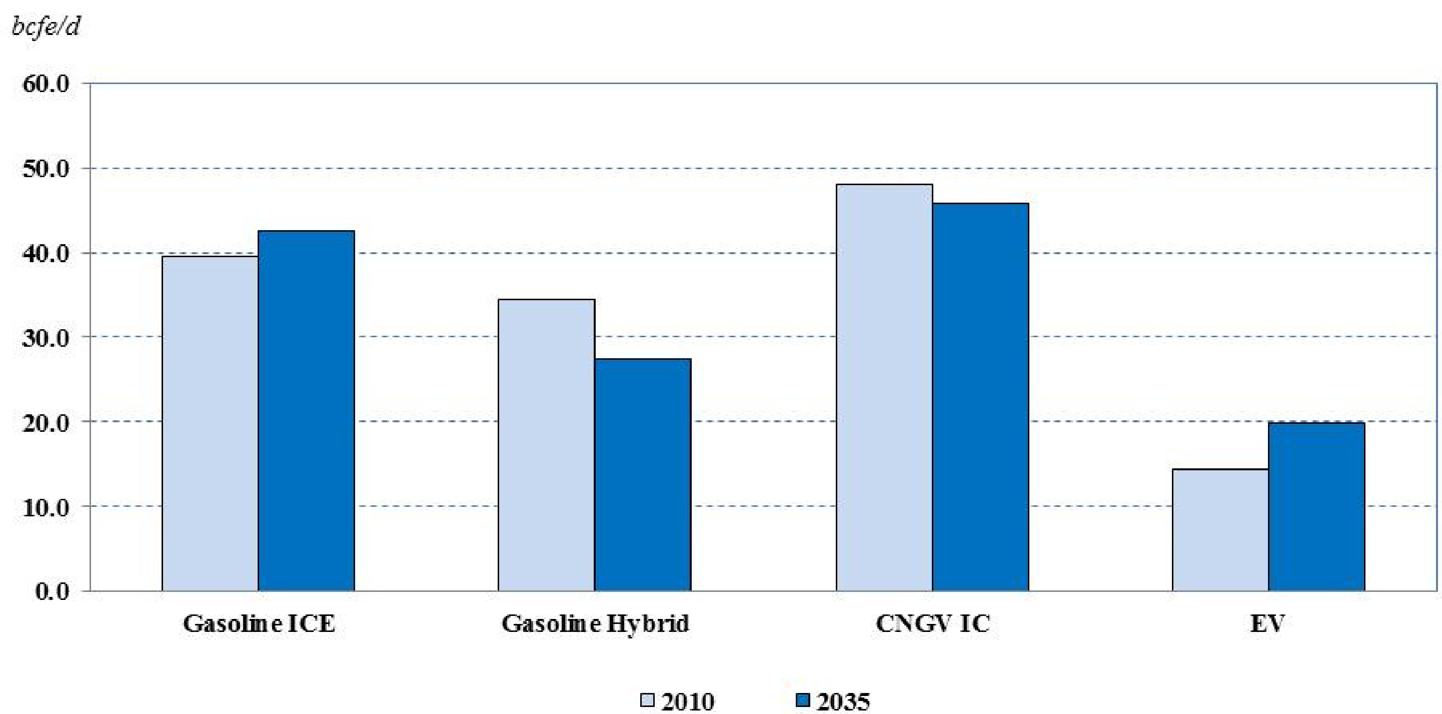
Calculated Energy Use for Different Vehicle Technologies (in mcf equivalent per vehicle)

- Using the methods outlined above, we see that the energy use per vehicle for all technology types, except EVs, declines over time. This is reflective of higher fuel efficiency.



Calculated Energy Use for Different Vehicle Technologies (in bcf equivalent per day)

- Assuming the entire vehicle stock uses one of the four technology types considered herein, we see that EVs have a much lower energy demand footprint, despite the growth in fuel use per vehicle seen in the EIA data. Notably, CNGVs are the most energy intensive of the four options.



Implied CO2 Emissions for Different Vehicle Technologies

- Assuming the entire vehicle stock uses one of the four technology types considered herein, we see the CO2 footprint of EVs is the lowest. However, CNGVs are more environmentally benign that gasoline vehicles, but not gasoline hybrid vehicles.