Electrifying Transportation in Virginia

Mark Webb
Director – Policy and Business Evaluation
Alternative Energy Solutions
Dominion Resources, Inc.

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What are HEVs, PHEVs, and EVs?

Hybrid Electric Vehicle (HEV)

- Primarily an internal combustion engine car with some electric vehicle functionality
- Gasoline and electric power sources, and two parallel paths to power the wheels
- Example: Toyota Prius

Plug-In Hybrid Electric Vehicle (PHEV)

- Uses both gasoline and electricity
- Rechargeable batteries allow longer electric-only drive distance
- 40 mile electric range/400 miles total
- Example: Chevy Volt

Electric Vehicle (EV)

- Also called Pure EV (PEV), Full EV (FEV), or Battery EV (BEV)
- No use of gasoline
- Electric motor powered by large, rechargeable battery 100-200 mile range per charge
- Example: Nissan LEAF, Tesla Roadster

Source: PRTM Management Consultants

The PHEV/EV Marketplace

- **Major automobile manufacturers are increasing PHEV/EV production lines for 2010 through 2013 delivery**
  - **Approximately 35+ new EV models over next 3 years**
- **Potential downward pressure on emissions and increasing CAFE standards may provide sustainable support for manufacturers**
- **Reductions in incremental cost, advancing battery technology, availability of tax incentives, and higher gasoline prices have driven new hybrid vehicles sales to 8% of current U.S. car and light truck sales**

***Source*: Polk automotive sales data**

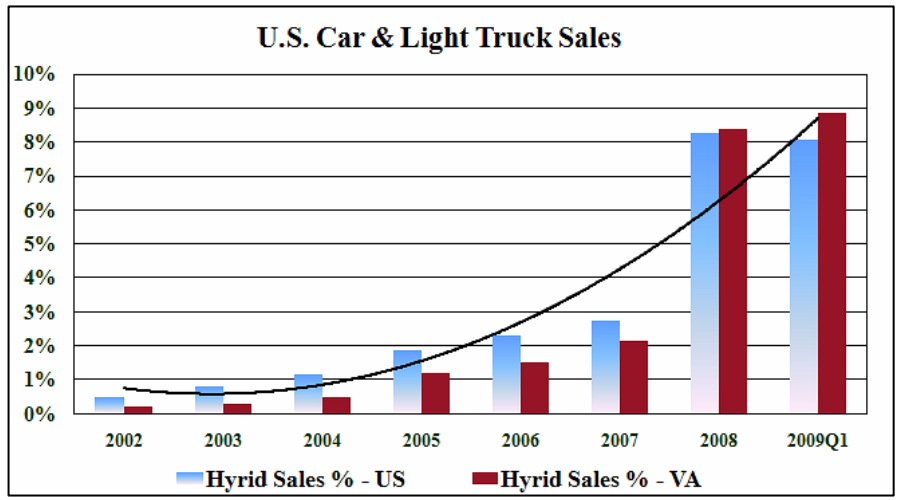


Figure 2

Hybrid Penetration (Top 5 States)

State	Hybrid Share of all Retail Registrations
District of Columbia	7.0%
California	5.9%
Oregon	5.5%
Washington	5.1%
Colorado	3.9%

***Source*: Polk automotive sales data**

PHEV/EV Market Place Entrants

Approximately 35 New Models by 2013

Ford Transit Connect

Tesla Roadster

CODA Sedan

Chevy Volt

Nissan LEAF

Mitsubishi i-Miev

BYD e6

Fisker Karma

Ford Focus

Toyota Prius PHEV

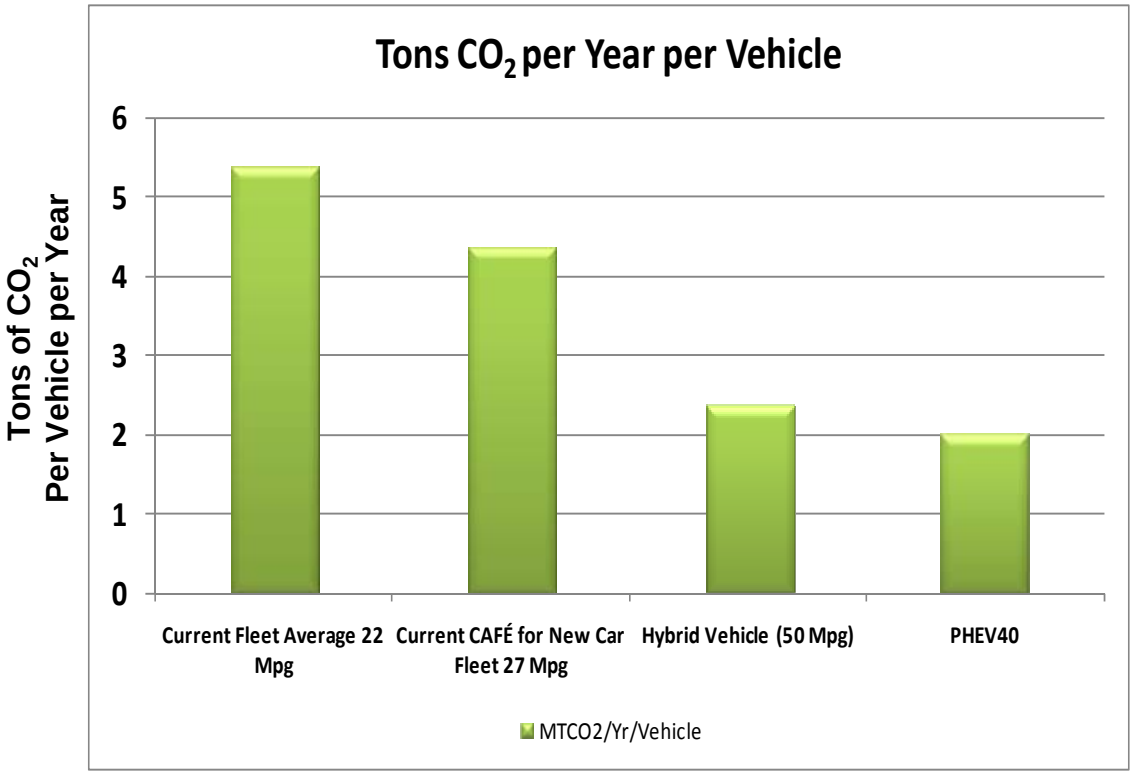
Toyota RAV4-EV

Smart Fortwo ED

Tesla Model S

2010 2011 2012 2013

PHEV/EV Benefits – Reduction in Carbon Emissions



***Note: Assumes 12,000 Miles/year.**

Electric power CO_2 emissions calculated using 2007 average US grid intensity, (1.33 lbs/kwh).

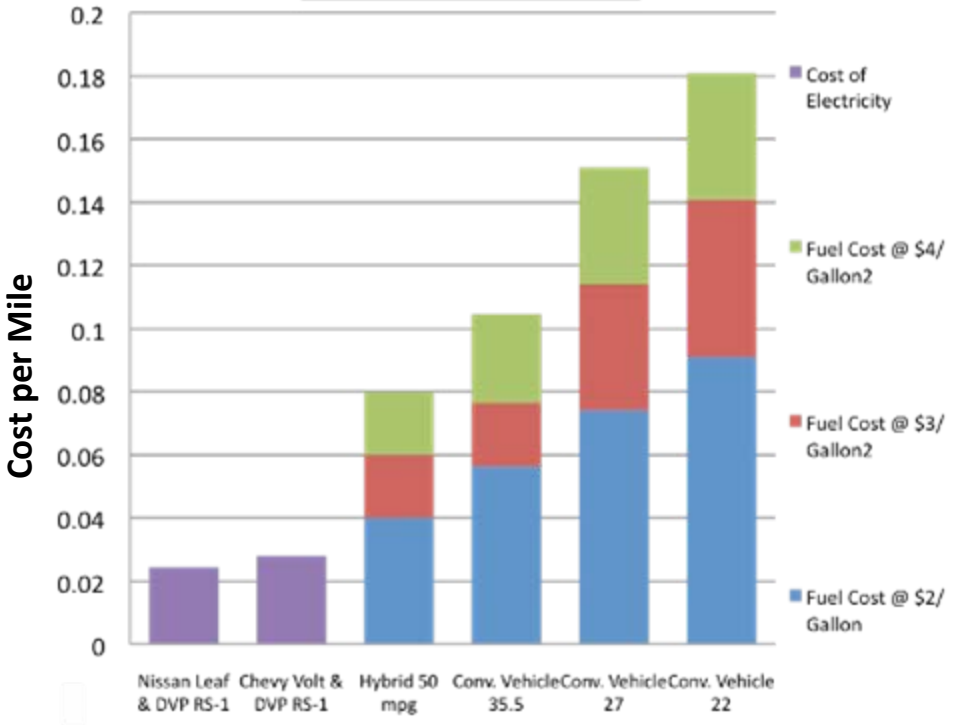
The Nissan LEAF, an all-electric car, would likely produce even lower emissions.

PHEV Emission Advantage

- **Transitioning transportation to electrification**
- **The carbon intensity of the electric grid is lower than transportation fuels**
  - **Continue to lower carbon intensity of electric grid via state RPS programs and regional carbon regulation already in place**
- **The fuel used to generate electricity in the US originates primarily in North America**

PHEV/EV Cost of Ownership

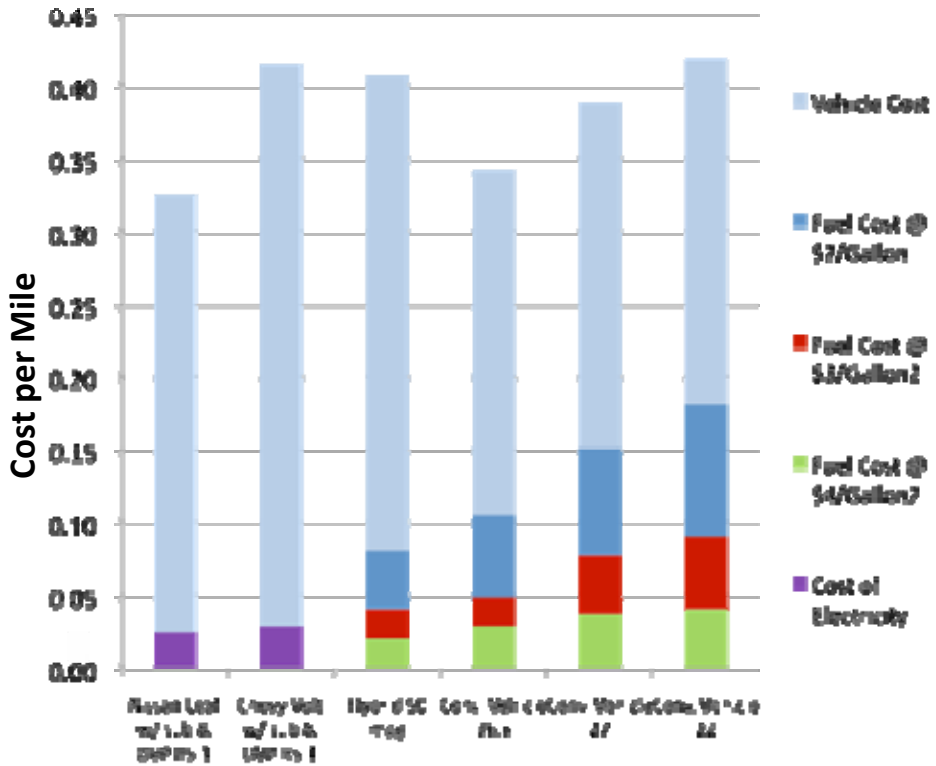
Fuel Cost



PHEV's are 50% less expensive to fuel even at low gasoline prices.

***Note: Average Va. Rate of 11.2 cents per kWh.**

Total Cost



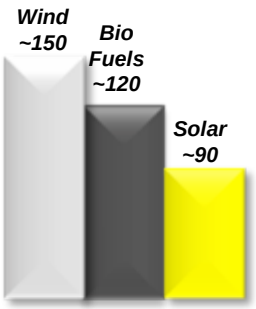
PHEV's with existing tax subsidy are price competitive.

***Note: 1) 7 year life, no maintenance cost, and 12K Miles/year**
2) PHEV40: $32.5k ($40k – $7.5k tax credit), Hybrid (Prius): $27.5k, Conventional (Corolla): $20k.
Electric Rate: Average VA 11.2 c/KWh

Economic Development

Potentially $250 Billion Global Market

By 2020 Clean Tech Power Sectors will be $100-$150



Clean Tech Power

Accelerator Effect?
- **Clean EV power**
- **Battery Storage**

The EV Value Chain will likely be 2-3x larger.

Energy Gen & Distribution	Fueling/ Grid	Components	EV Vehicles	Services
Incremental Electricity Sales for 30M EV/PHEV: $20 B	Infrastructure Investment @ $1,000/vehicle: $30 B	Li-Ion Batteries Used in EV/PHEVs: $50 B	EV/PHEV Sales w/out Batteries: $185 B	Advertising/Co-Branding/Services: ?

Source: PRTM Management Consultants

Projected PEV Distributions
Should Track Toyota Prius Sales

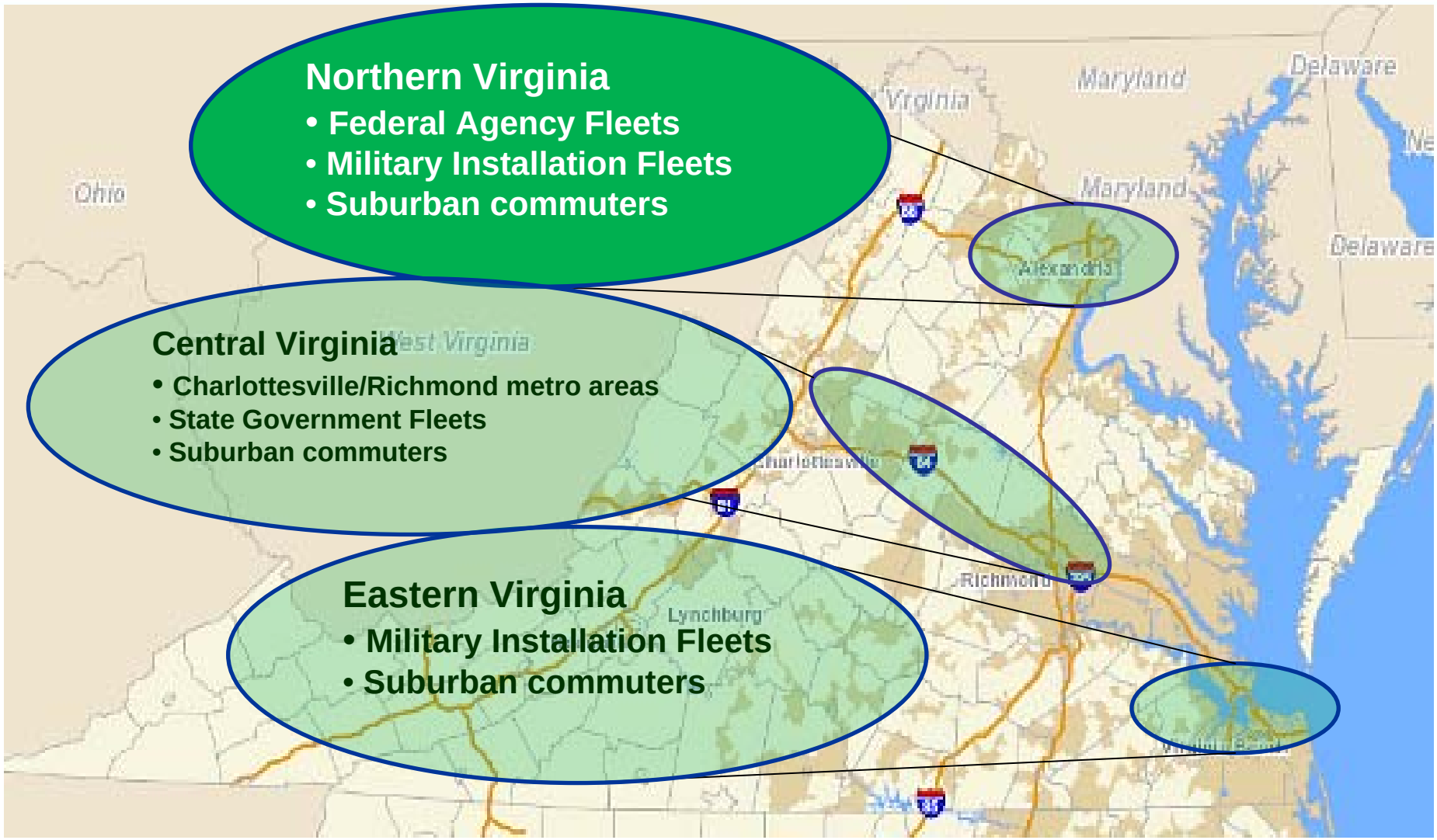
Table 3. PEVs in the Top Twenty Most Populous Metropolitan Areas

City	Consumer PEVs	Fleet PEVs	Total PEVs
New York	40,000	14,069	54,069
Los Angeles	105,000	14,069	119,069
Chicago	20,000	7,892	27,892
Washington, DC	31,000	6,520	37,520
San Francisco	85,000	6,005	91,005
Philadelphia	13,000	5,319	18,319
Boston	27,000	4,976	31,976
Detroit-Ann Arbor	6,000	4,718	10,718
Dallas-Fort Worth	6,500	4,461	10,961
Houston	8,000	4,032	12,032
Atlanta	4,500	3,517	8,017
Miami	8,000	3,346	11,346
Seattle-Tacoma	23,000	3,088	26,088
Phoenix	13,000	2,831	15,831
Minneapolis	8,000	2,574	10,574
Cleveland-Akron	6,000	2,574	8,574
San Diego	20,000	2,445	22,445
St. Louis	3,500	2,230	5,730
Denver-Boulder	9,000	2,230	11,230
Tampa-St. Pete	7,000	2,059	9,059

Note: Metro areas located within the ISO/RTO study are **bold**; other metro areas are in gray

Source: KEMA's "Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems"

Early Adoption Areas in Virginia



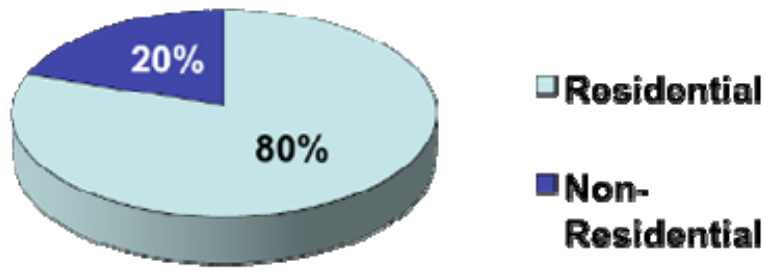
Electric Vehicle Charging Basics

Levels of Charging

Level of Charging	Level 1	Level 2	DC Fast Charge (Level 3)
Voltage	120	240	480 (off board charger provides AC to DC conversion)
Amperage	15 - 20 Amp	40 - 80 Amp	85 Amp
Instantaneous Demand	1.2 - 1.6 kW	3.3 - 7.7 kW	60 kW
Charge Time			
PHEV 40 Vehicle	5 - 13 hours	2.5 - 5 hours	N/A
EV100 Vehicle	8 - 15 hours	3 - 5 hours	15 to 30 minutes

- **Any standard 120v outlet can provide a Level 1 charge**
- **Level 2 charging requires special EVSE and a dedicated 240v circuit**
- **DC Fast Charging or Level 3 charging requires three-phase electric service**

Projected Charging Distribution by Location



Note: Non-residential includes both public and workplace charging; we anticipate workplace place charging to initially occur more frequently

Load and Charging Projections in the US ISO/RTO Regions

ISO/RTO	Total PEVs	Load if everyone charged at the same time (MW)	Load if charging is staged over 8 hours (MW)	Load if charging is staged over 12 hours (MW)
ISO-NE	61,074	338	75	50
NYISO	43,738	242	27	18
PJM	144,172	797	178	119
Midwest ISO	94,644	523	117	78
SPP	30,459	168	38	25
ERCOT	42,769	237	53	35
CAISO	267,654	1,480	331	221
TOTAL	**684,510**	**3,785**	**819**	**546**

Source: KEMA's "Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems"

- **Total PEVs and loads based on vehicles "living" in ISO/RTO regions**
- **Target curve meets Obama Administration's goal of one million PEVs in the US by 2017**
- **Penetration in all cases is based on the Prius model for consumer behavior, with increase due to fleet introductions after 2012**
- **Does not include areas that are outside of ISO/RTO Regions**
  - **Southeast (Including most of NC and all of SC, GA, FL, and TN)**
  - **West (Including parts of CA and all of OR, WA, AZ, CO, and NV)**

What is Dominion Doing?

- **Current company owned EVs**
  - **2 converted Toyota Prius sedans**
  - **4 bucket trucks (EPRI Eaton Study)**

- **Dominion will lease two Chevy Volts for research and interoperability assessment**
  - **Track usage of PHEVs to validate loading model**

    - **DVP has installed Shore Power units at New Kent County West Bound 64 Rest Area**

- **EPRI Study Completed on Glebe Road - Circuit 328**
  - **Determine whether T&D capacity will be sufficient to supply the increased demand of PHEV charging**

- **Participated in *Virginia Project Get Ready* Initiative to educate the public about vehicle electrification and make recommendations for Virginia**

- **Participating in *EEI Transportation Electrification Task Force***

Electric Vehicle Charging Policy Issues

- **Can non-utilities install, own, and operate public charging stations in Virginia?**
  - **Laws regarding this subject vary widely across the country.**
  - **Issue likely to be resolved on a state by state basis.**
  - **To date, California is the only state in which this question has been resolved.**
- **Should an electric rate be offered to incent off-peak charging?**
- **How will electric utility infrastructure costs be recovered for charging installations?**
- **Who should be responsible for public charging facilities?**
- **How will municipalities deal with building codes, permitting, vehicle parking and charging?**
- **What role should the Commonwealth play to ensure that standards, technologies, and safeguards related to electric vehicles are established in a consistent and harmonious manner?**
- **Should electric vehicle users be required to bear all costs of electric vehicle infrastructure when the benefits of electric vehicles (cleaner air, EPA compliance, and energy independence) will be enjoyed by all citizens?**
- **How will states capture the lost tax revenue from gasoline sales?**

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