



Plug-in Hybrid Electric Vehicles Significant Market Potential

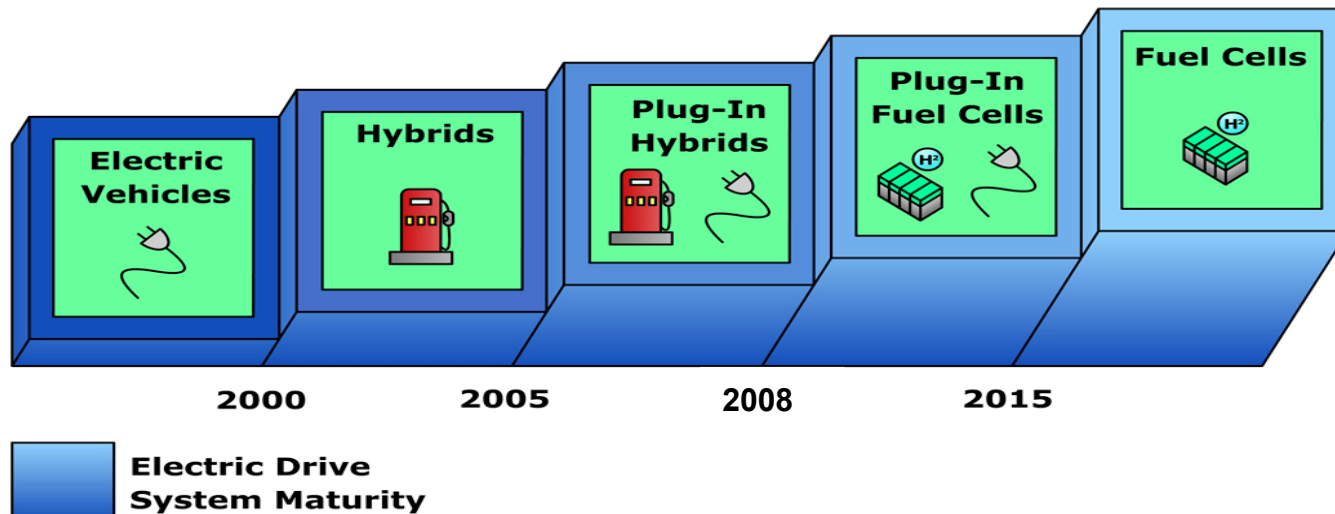
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Electric Transportation

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Market Transformation of Electric Drive Vehicles

- Plug in hybrid vehicles enlarge the growing family of hybrid drive vehicles
- Plug in hybrid vehicles provide the bridge between fuel cell vehicles and hybrid vehicles
- Plug in hybrid vehicles enable the return of battery electric vehicles to the mass market



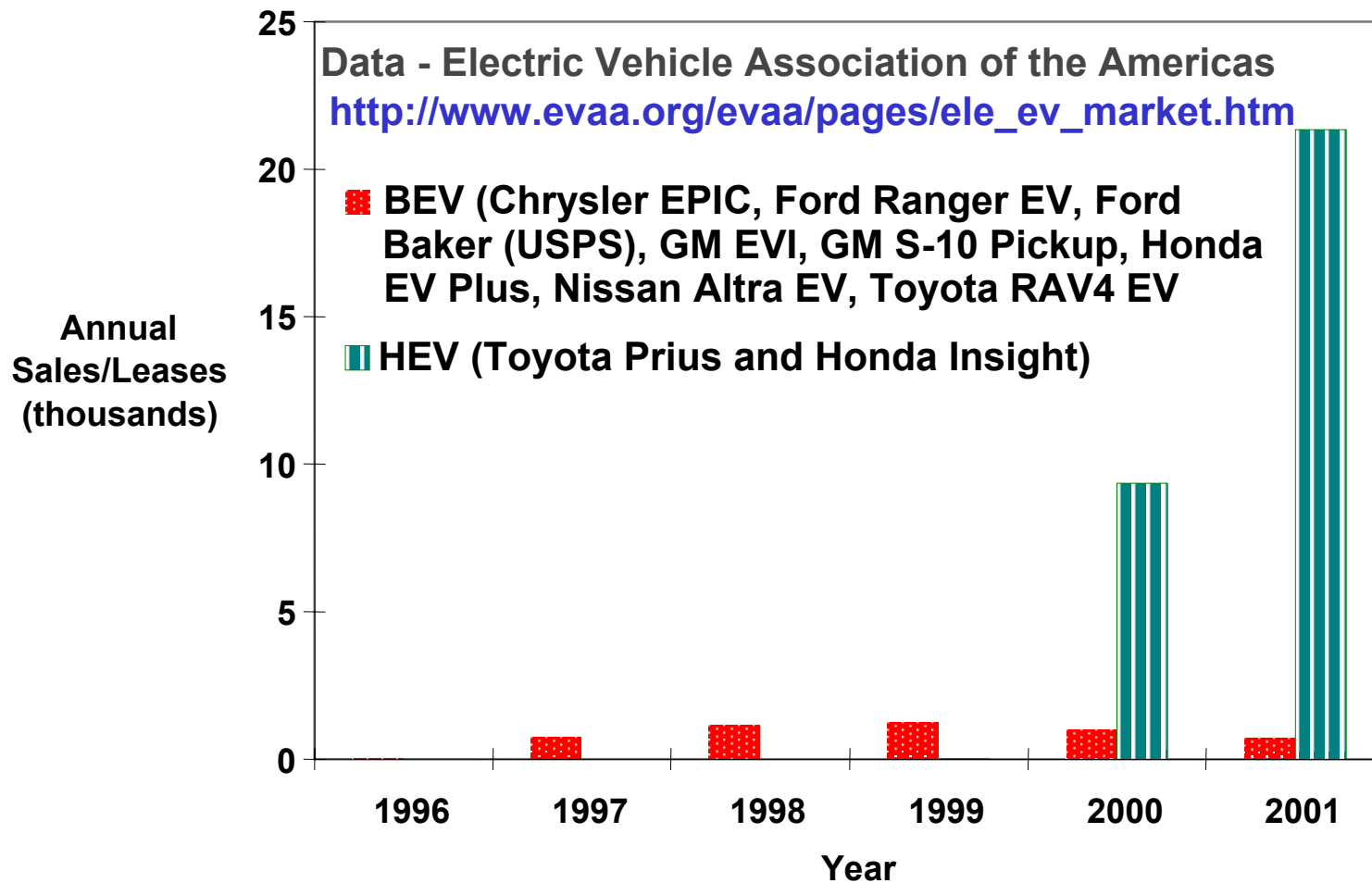
The Road to Significant Plug-in HEV (PHEV) Market Share Begins with Marketable HEV-0

- HEV-0 EDV commercialization provides immediate benefits:
 - Customer acceptance of electric drive systems
 - Component volume
 - Battery manufacturer engagement with advanced batteries
 - Market pull for energy efficient vehicles
- The PHEV is the logical next member of the family of hybrid vehicles. According to participants in focus groups:
 - All electric miles with the resulting reduction in emissions and petroleum consumption attract significant attention
 - PHEV-20 will have broad market appeal, especially if the price differential with the HEV-0 is not excessive.

The Road to Significant Plug-in HEV (PHEV) Market Share begins with Marketable HEV-0

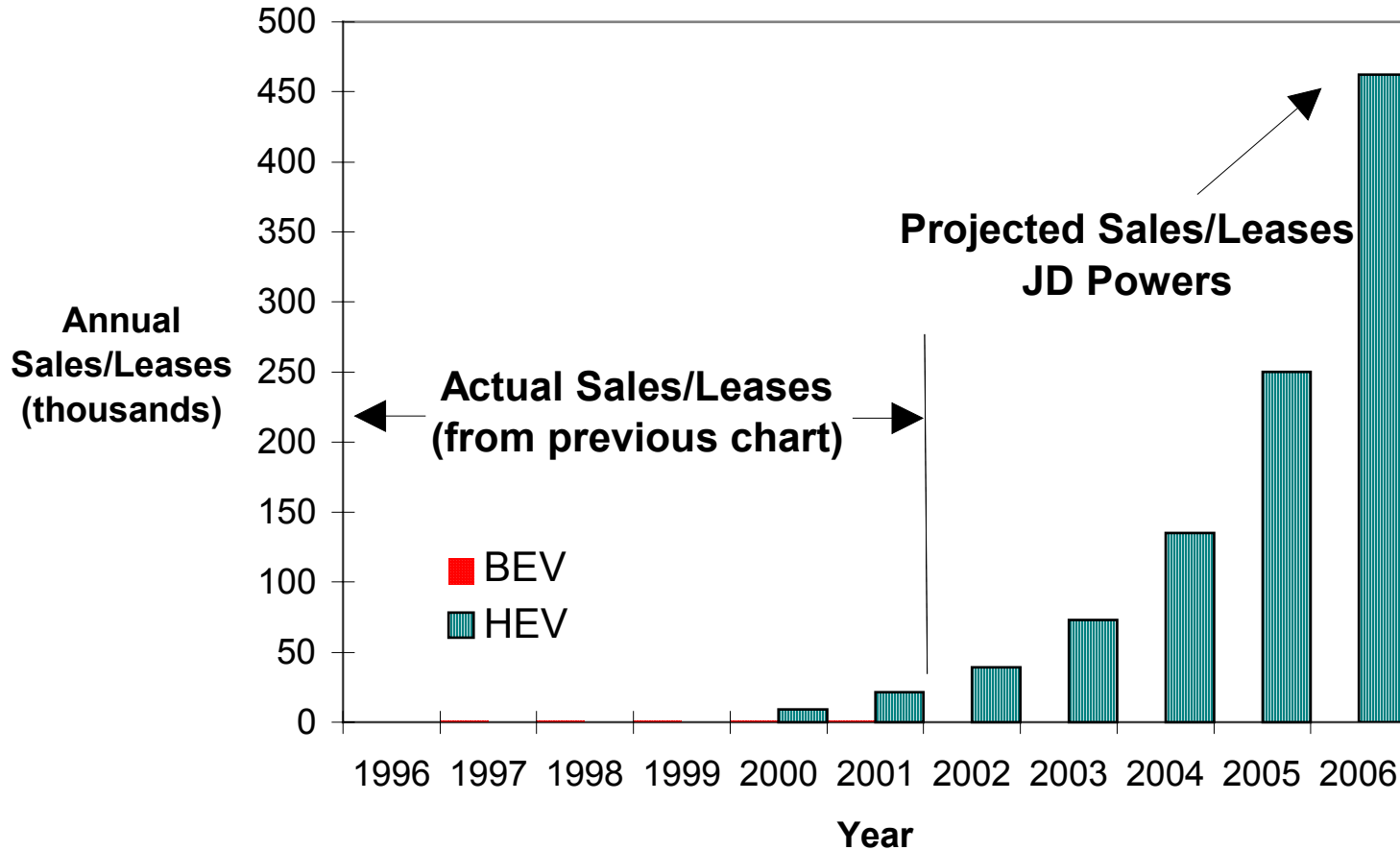
- PHEV platforms will also be the forerunners for fuel-cell HEVs.
- As HEV-0s and PHEVs are commercialized and battery costs drop:
 - Full-size BEVs are likely to become more marketable.
 - Specialty BEV markets (like NEVs, station car, etc.) will grow.

The HEV-0 is Accelerating the Market Transformation to Electric Drive Vehicles (EDV)



HEV-0 Annual Sales to Approach 500K by 2006

Source: JD Powers



Economic Value of Electric Drive Vehicles

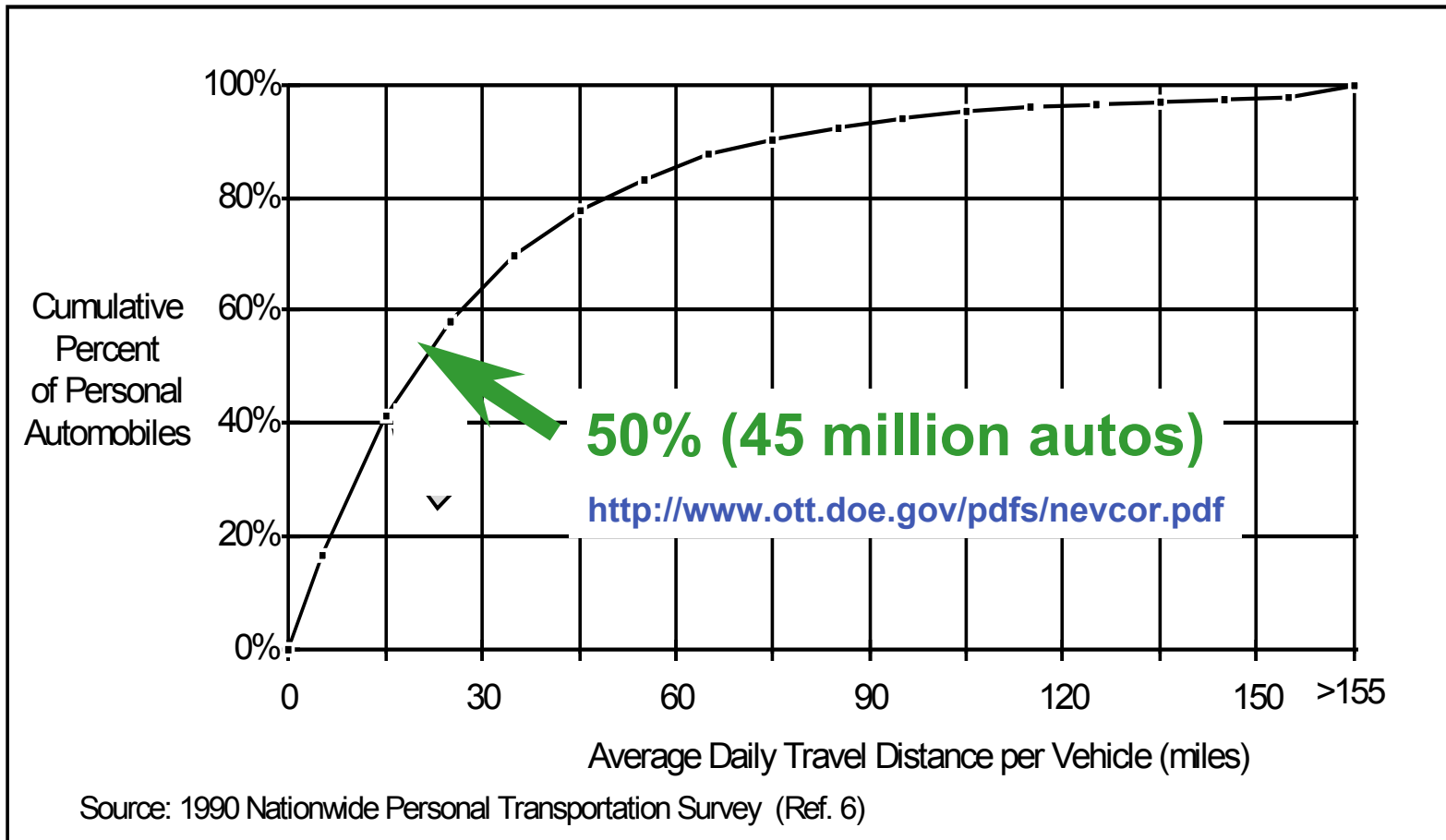
Source: EPRI Roadmap Study

- Assume 25% total plug-in vehicles (BEVs & plug-in HEVs) nationwide by 2025
- DOE – EIA projections for energy use
- \$88.9 billion net annual economic benefit
- Dramatic reduction in criteria pollutants = health benefit
- Very large spillover benefits to other industries

<i>Net Economic Benefit</i>	<i>Billion \$/yr (2002\$)</i>
Balance of Trade	\$ 26.3 B\$/year
GDP Impact	\$ 38.3 B\$/year
Environmental	\$ 9.3 B\$/year
Military	\$ 7.5 B\$/year
Spillover benefits to other industries	Not calculated
Oil Disruption	\$ 7.5 B\$/year
Labor	440,000 Jobs/yr

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Half of All Autos on the Road on a Typical Day Travel a Total of 20 Miles or Less



PHEV 20 - A Growth Opportunity

- Half of all autos on the road on a typical day (45 million autos) will travel 20 miles or less, almost all of these same autos will also travel on some other days 200 miles (or 300 miles or ...).
- The typical daily trips totaling 20 miles or less could be driven in PHEV-20s as ZEV miles with no use of petroleum fuels whatsoever.
- Longer trips in the PHEV could begin as ZEV miles and be completed using fuels.
- PHEV benefits include all of the HEV-0 benefits and the PHEV offers plug-in AER (All Electric Range), like the BEV.

The Benefits of Only 20-Mile All Electric Range (AER)

ZEV miles and petroleum displacement on those trips with the highest emissions and poorest fuel economy

- AER miles are non-petroleum miles; AER miles:
 - Increase national energy security.
 - Provide mobility security in the event of fuel shortages.
- 20-mile AER displaces trips with the highest emissions and poorest fuel economy.
 - Daily travel of 20 miles and less is dominated by short, stop-and-go trips.
 - Engines are cold and they are idling, accelerating or decelerating for significant fractions of the time.
 - Consequences are: disproportionately high per-mile levels of emissions and poorest fuel economy.

Additional Benefits of the Full Family of Plug-in HEVs

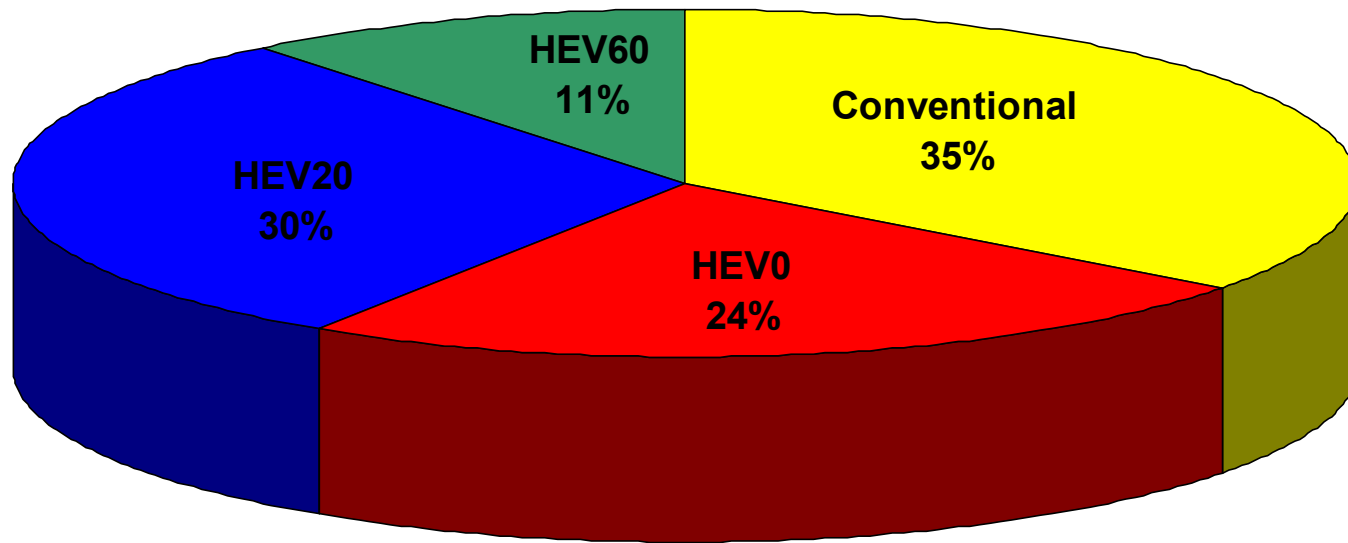
- Solve issue with BEV range limitations, infrastructure, cost yet retain proven customer interest
- Contain all the features consumers love about EVs
- Allow consumers to experience/learn about plug-in ZEV technologies
- A full family of vehicles meeting all consumer desires
- Don't need to wait for an electrical upgrade or hydrogen refueling stations or be limited to fleets
- Enable plug-in fuel cell vehicles which are expected to lower the cost of no plug fuel cell vehicles

Additional Benefits of Plug-in HEVs

- Aren't impacted by power outages or forgetting to plug in
- Don't need to be charged quickly or impact utility systems
- Can still use the battery when it is less than 80% of original energy and power
- Work for high mileage drivers
- Work for residents of many apartments and condos
 - 95% of homes and 70% of multi-family dwellings have relatively easy access to a 120 V plug
- Work for single car households

Market Preference

Full-Size SUV - \$1.65/gallon Gasoline



Strong market preference for plug-in hybrid vehicles when performance is equal and cost difference is reasonable.

HEVWG Customer Preference Study

- HEVWG Phase 1 and 1.5 on market potential – 3-year, \$0.75 million study sponsored by EPRI, CARB, SCAQMD, and utilities
- GM, Ford, Utilities, UCD, EPRI, and government partners worked closely with Applied Decision Analysis to design the format, questions, and education overheads of the study.
 - HEVWG teams on cost and benefits all fed into the study
 - The very sophisticated model provided customized cost and benefit information to each interviewee based on their driving patterns and vehicle type.
- Focus was to see if plug-in HEVs and no-plug HEVs had potential in the long-term
 - We focused respondents on their preferences in 10 years for well-established power train options (CV or HEV) not on any other differences in the vehicle itself

Overview of HEVWG Market and Cost Study

- As expected HEV market potential is very sensitive to price.
 - e.g. Tax credits can make a big difference
 - e.g. Automaker competition or customer based pricing can make a difference
 - To improve image or capture new markets or remain competitive in key segments
- There appears to be worldwide business case for HEV 0s
 - And with the HEV 20 having an RPE of only \$1,500 to \$2,000 more than the HEV 0 it appears the HEV 20 or similar is the next logical step and business case

A Market Does Exist

The sophisticated \$0.75 million HEVWG consumer research study shows plug-in HEV “buyers”:

- Like plug-in HEVs
- Strongly prefer plugging in
 - 63% strongly preferred plugging in each night vs. 1% strongly preferred the gas station
- Want the fuel savings and 10 other benefits
 - Large operating savings (e.g. mid-size car = \$7,000 saved)
 - Significant maintenance savings (cost / time)
 - Avoiding gas stations (60 – 85 % fewer trips)
 - Convenience of full battery every morning
 - Reducing air pollution, global warming, foreign oil
 - Increased quietness / less vibration / fun to drive
- Understand that plugging in is necessary to get these benefits

Allowing Plug-In HEVs into the Gold with FCVs and BEVs Will “Bridge the Gap”

- Provide real pure-ZEV miles. (e.g. 40,000 to 120,000)
- No significant technological hurdles. Can be available 2006-07.
- Incremental cost is manageable and very clean electricity grid infrastructure here today.
- Provide the next best thing to a BEV and address two big barriers – marketability and battery cost
- Provide a “bridge” forward to FCVs, and a “path” back to BEVs.

Plug-in HEVs “Bridge the Gap”

- Provide a “business case” ZEV solution to Gold Category
- Provide the high volume cost reductions needed for “energy” batteries and can exceed gold category volumes
- Ensures significant ZEV miles in this decade
- Demonstrates the sound use of public policy to continue market transformation to electric drive systems