Vehicle Technologies Program

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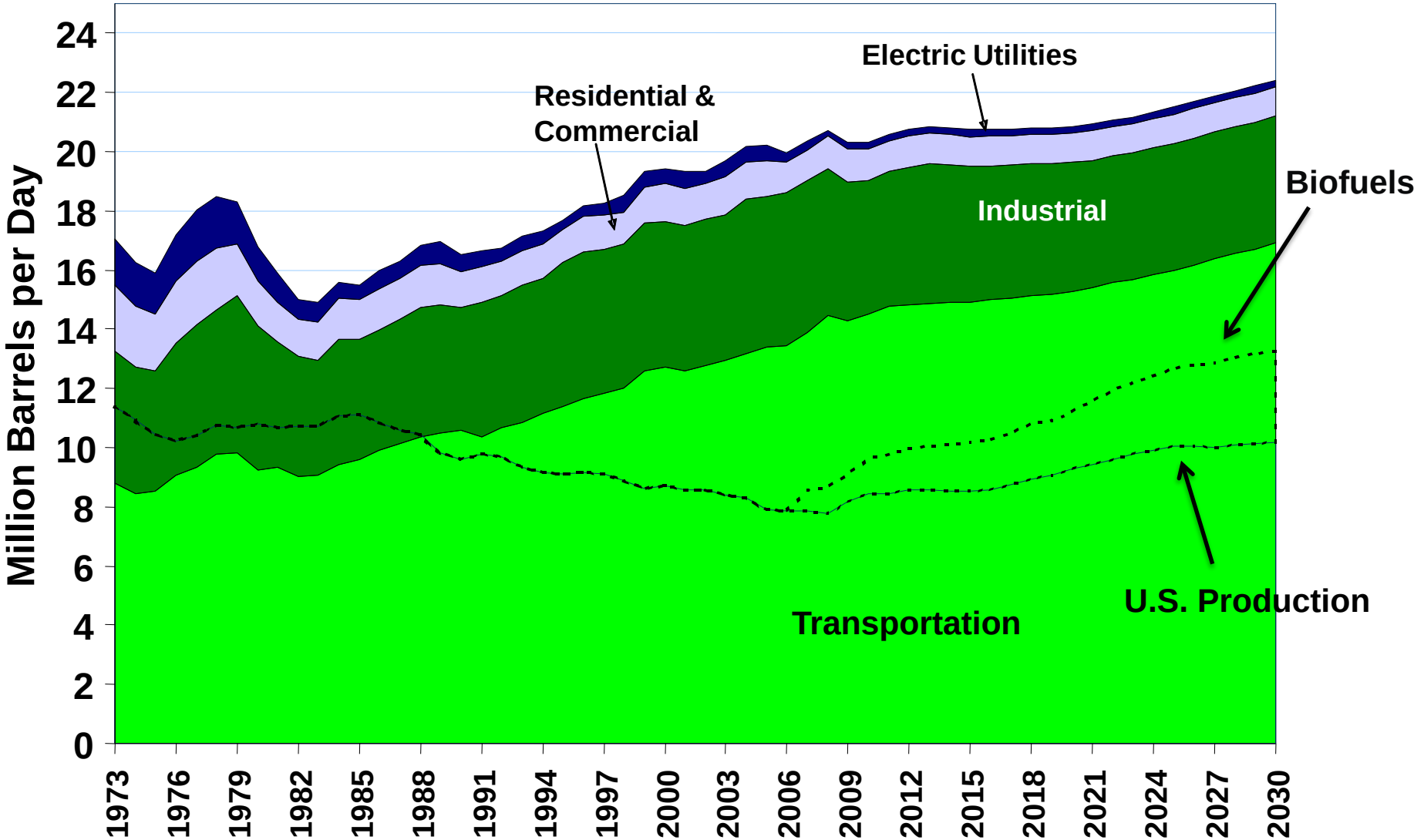
U.S. Petroleum Gap (2009)



U.S. Petroleum Production and Consumption, Transportation

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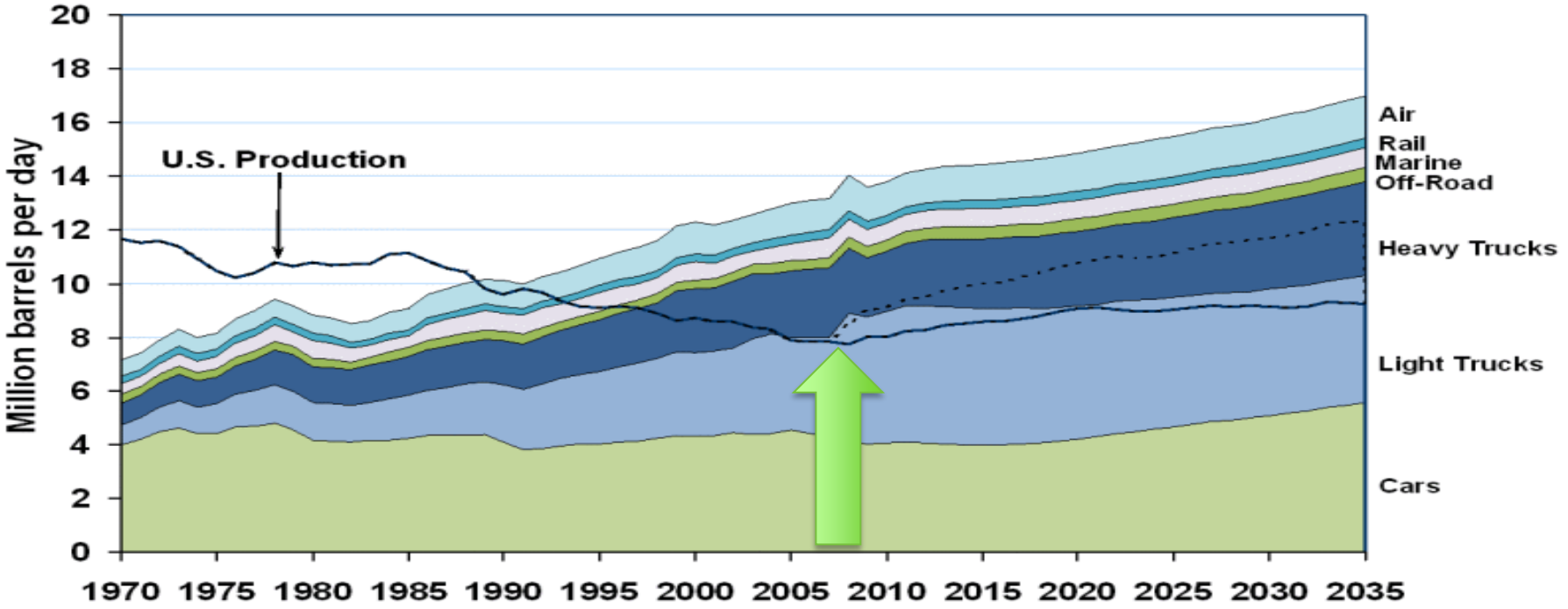
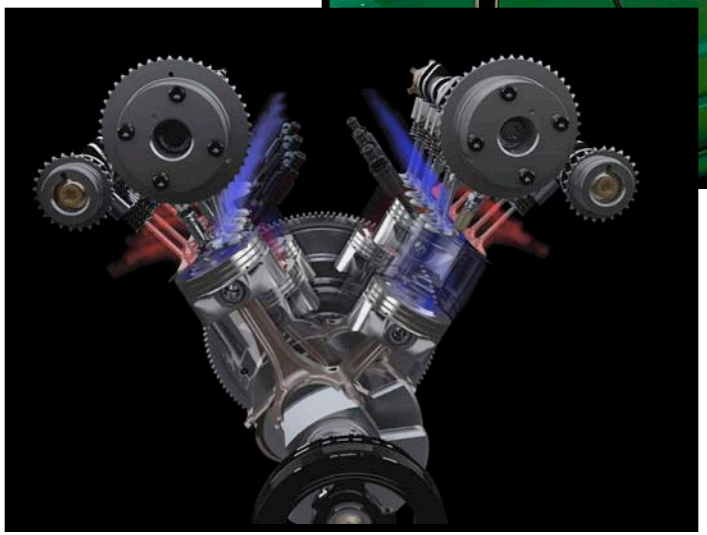


- 240 million vehicles on the road
- Approximately 9M new cars & light trucks for 2009. Average is 15.7 M/yr 2002-2007
- 11.5 Million barrels of oil per day consumed by on-road vehicles
- Light-duty vehicles consume 60% of transportation fuel, and account for 42% of total US petroleum use.

Where are the opportunities
for reducing transportation petroleum demand?
(In addition to walking more)

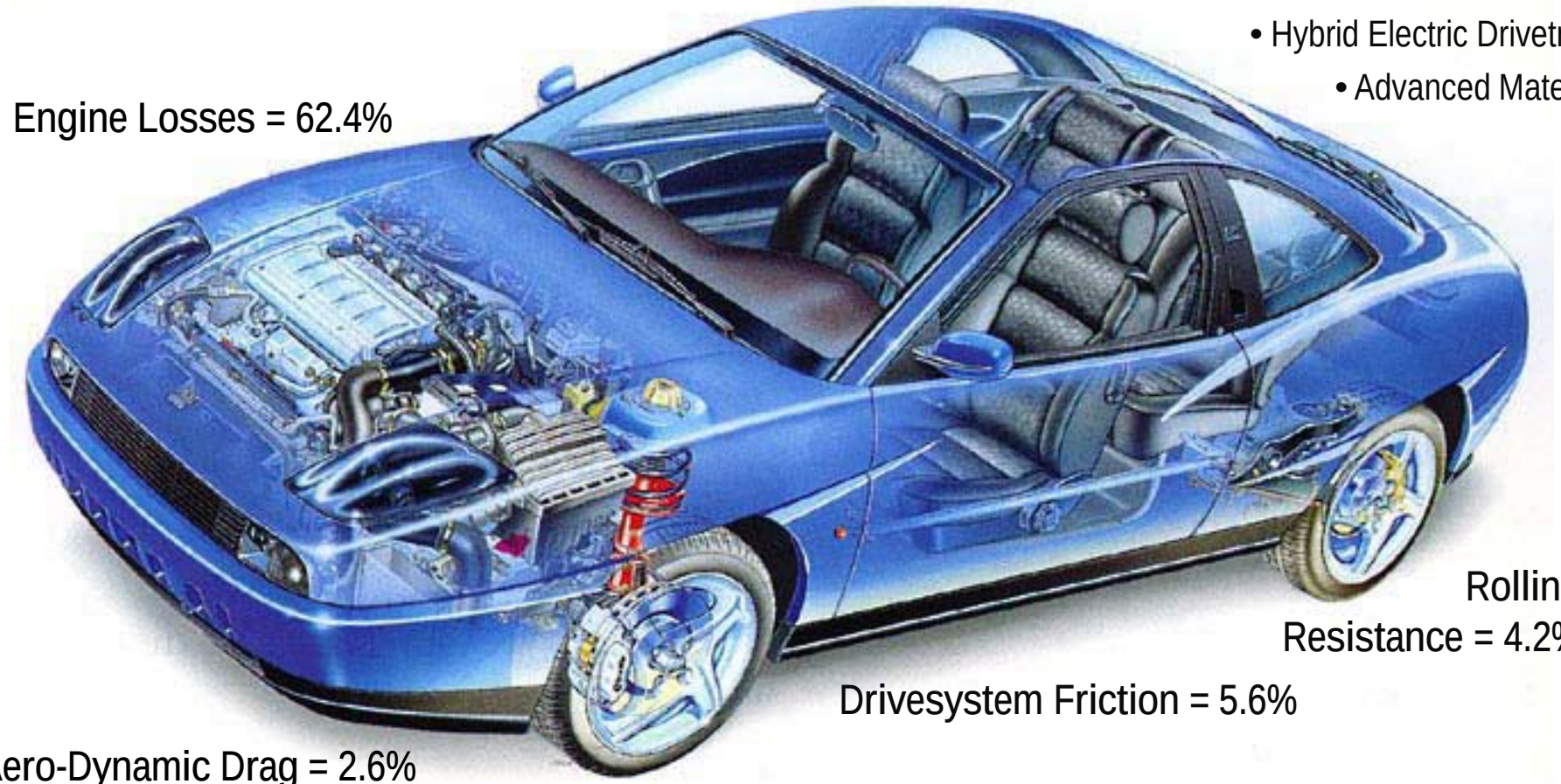


Vehicle Energy Consumption

Idling = 17.2%

Accessory Loads = 2.2%

Engine Losses = 62.4%



Rolling Resistance = 4.2%

Drivesystem Friction = 5.6%

Aero-Dynamic Drag = 2.6%

Inertia = 5.8% → **Brakes**

Vehicle Technologies

- Advanced Engine Development
- Automotive Fuel Cells
- Hybrid Electric Drivetrains
- Advanced Materials

Vehicle Energy Consumption

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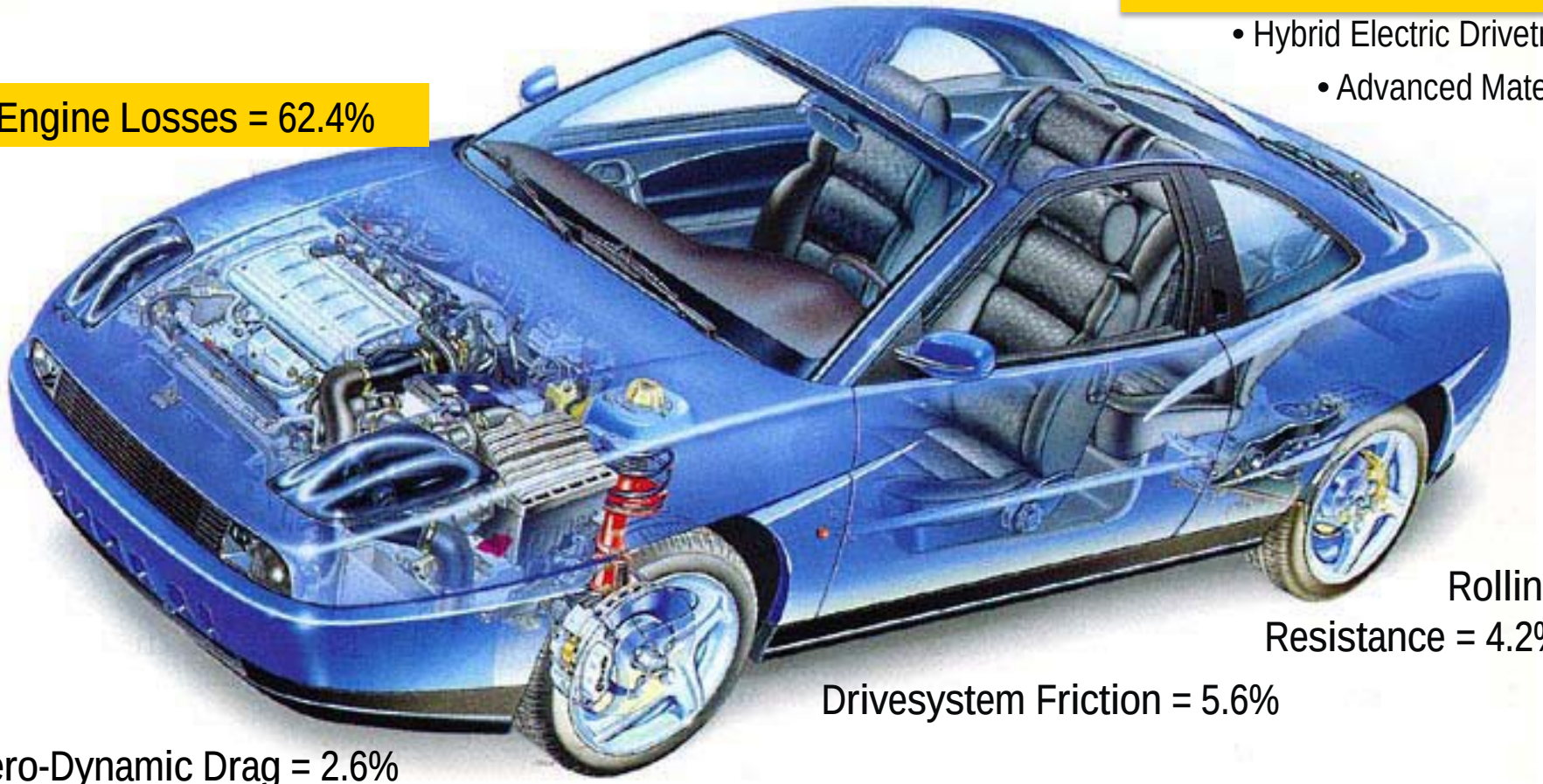

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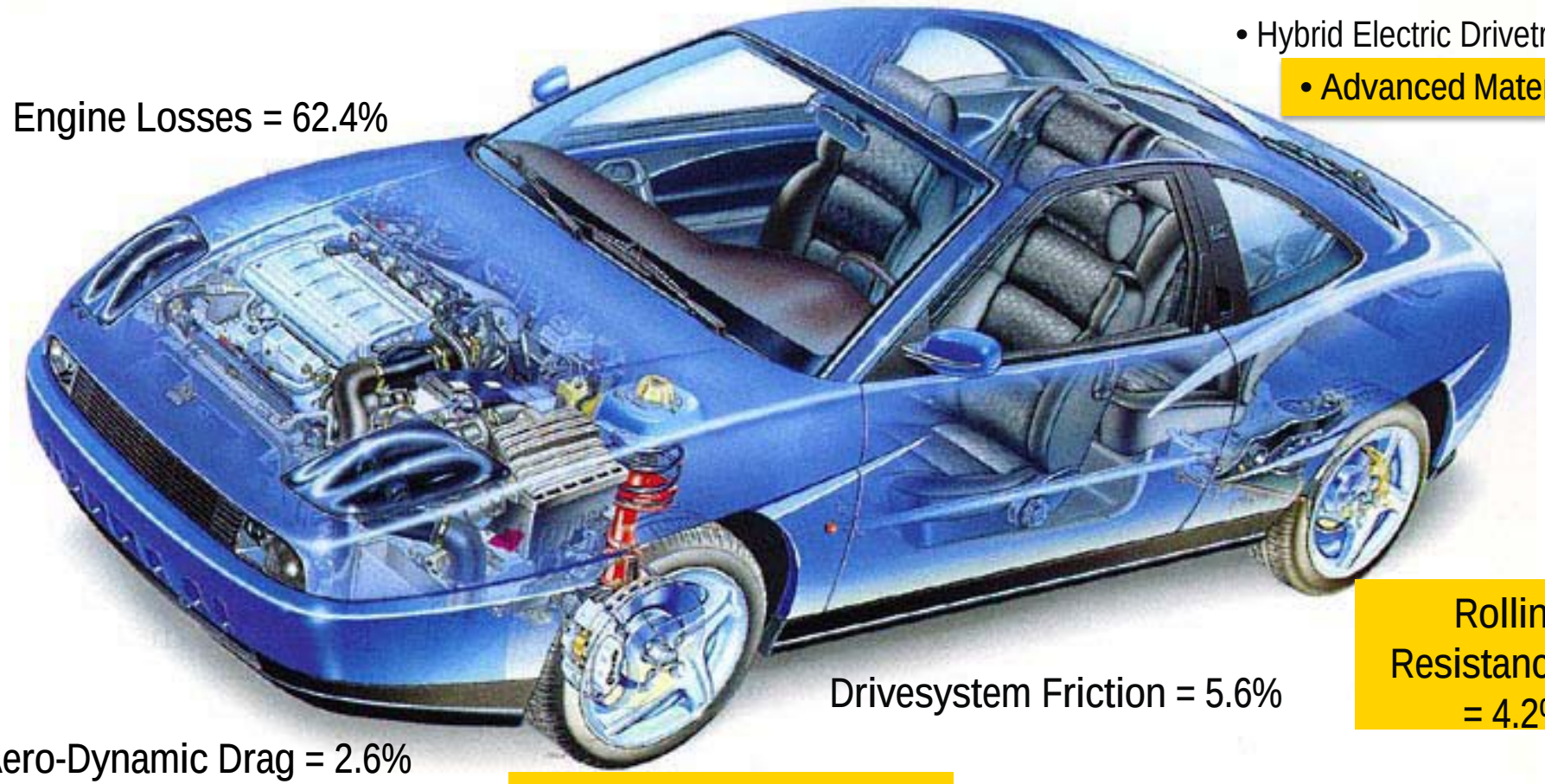

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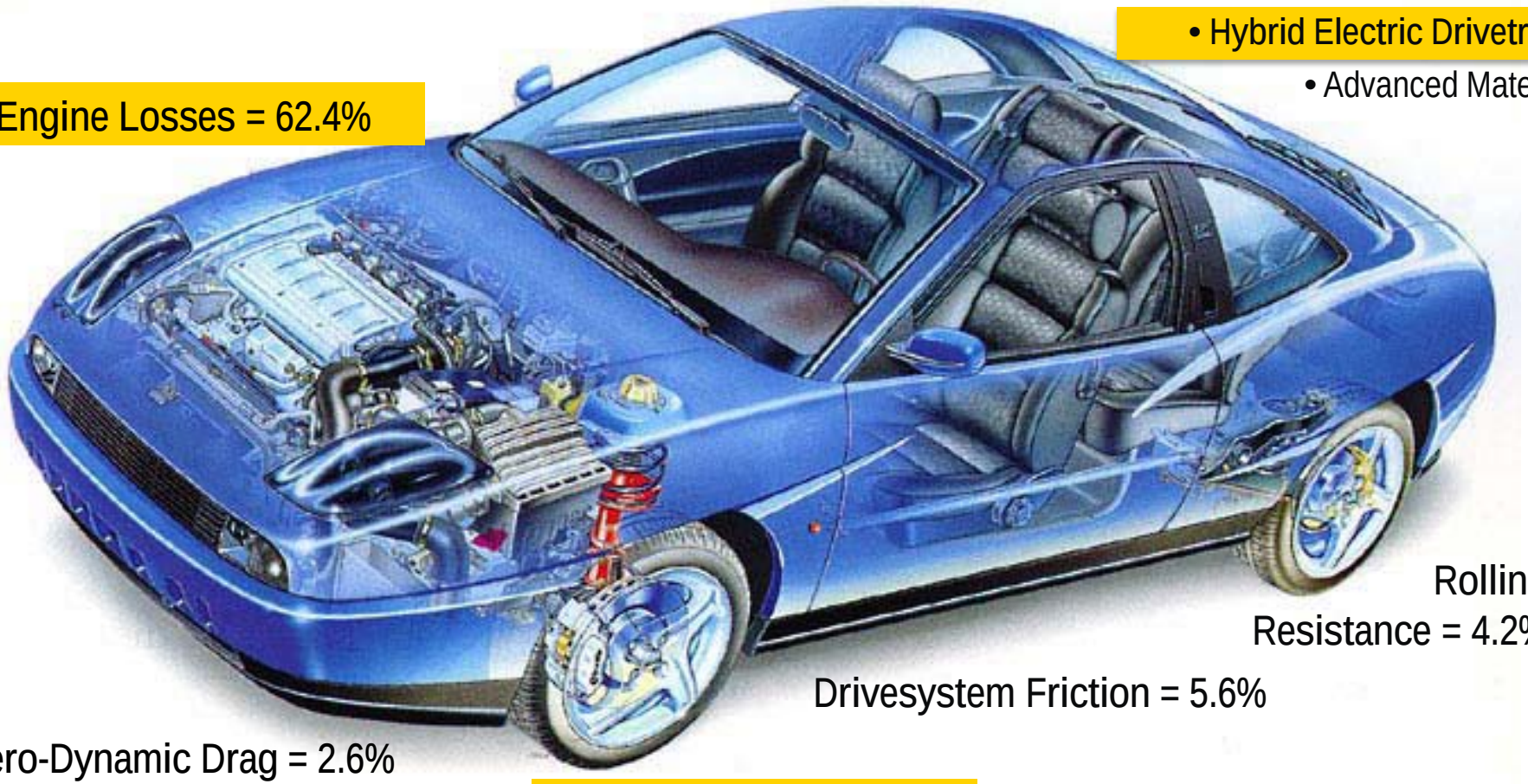

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Program Overviews

- Advanced Engine Combustion R&D
- Materials Development
- Batteries and Electric Drives
- Fuel Cells

Advanced Engine Combustion R&D

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Increasing engine efficiency a cost-effective approach to increasing fuel economy

"Support improved mileage performance of internal combustion engines…" – Secretary of Energy Steven Chu

Benefits All Vehicle Classes

Heavy-Duty

Class 2b-8

• Power Rating: 250-600hp



Up to 20% Improvement

Light-Duty

Cars

• Power Rating: 100-300hp


Trucks

• Power Rating: 200-400hp

25-40% Improvement

Status and Targets

Improve gasoline engine efficiency by advancing technologies such as lean-burn operation, turbocharging, variable valve actuation, variable compression ratio

2015 Passenger Vehicle: Improve gasoline vehicle fuel economy by 25% and diesel vehicle fuel economy by 40%; compared to 2009 gasoline baseline

2015 Commercial Engine: Improve commercial engine efficiency by more than 20%; compared to 2009 baseline

Materials Development

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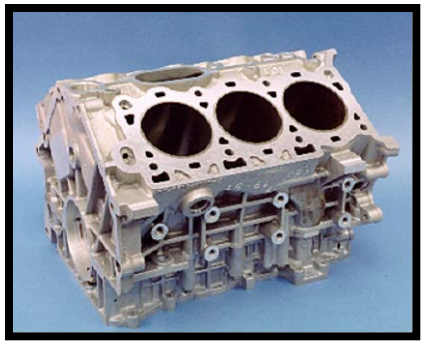
Vehicle lightweighting is a effective way of reducing fuel consumption

Lightweighting improves fuel economy and reduces the demands on the powertrain and ancillary systems (e.g., braking)

Types of Materials and Benefits



Magnesium

25-35% Lighter than a Aluminum Engine Block and 45-55% Lighter Compared to Cast Iron

Carbon Fiber

50-60% Lighter than a Standard Steel Body in White

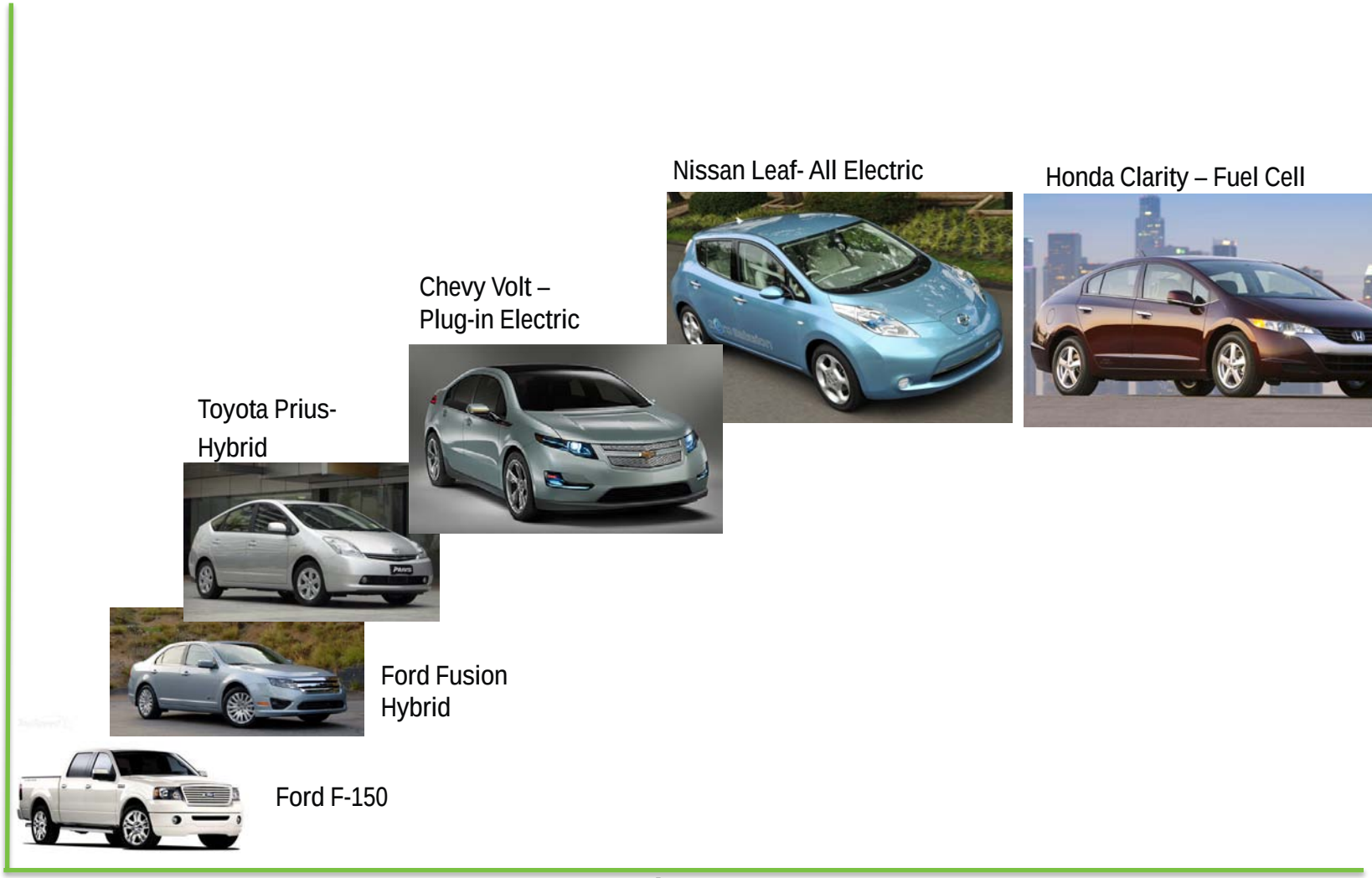
Targets and Status

2009 Status: Modeling demonstrated that body and chassis weight reduction goal of 40% could be achieved, *but not at cost parity*.
2009 Status: Thermoelectrics that convert engine waste heat directly to electricity which provides a 5% improvement in fuel economy on the highway

2015 Target: Validate cost-effective reduction of passenger vehicle body and chassis weight by 50% in high volume applications compared to 2002 vehicles.

2015 Target: Commercial introduction of thermoelectric coolers/heaters to replace vehicle A/C systems

Hybrid Electric Drive Options



Batteries and Electric Drive Technology

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Drivetrain electrification is inherently efficient and a clear pathway to low-carbon transportation. Program targets focus on enabling market success

Potential Benefits

- Potential oil savings in 2030 is ~1.25 million barrels per day (Mbpd)
- Corresponding GHG emissions reduction is ~170 million metric tons of CO2 equivalent (MMTCO2e)

Types of Vehicles and Benefits

HEV →

Toyota Prius → 50 MPG

- 1 kWh battery
- Power Rating: 80kW
- System Cost: $3000

PHEV →

Chevy Volt → 100 MPGe

- 16 kWh battery
- Power Rating: 170kW
- System Cost: est. $16,000

EV →

Nissan Leaf → All Electric

- ≥ 40 kWh battery
- Power Rating: ≥ 110kW
- System Cost: est.$36,000

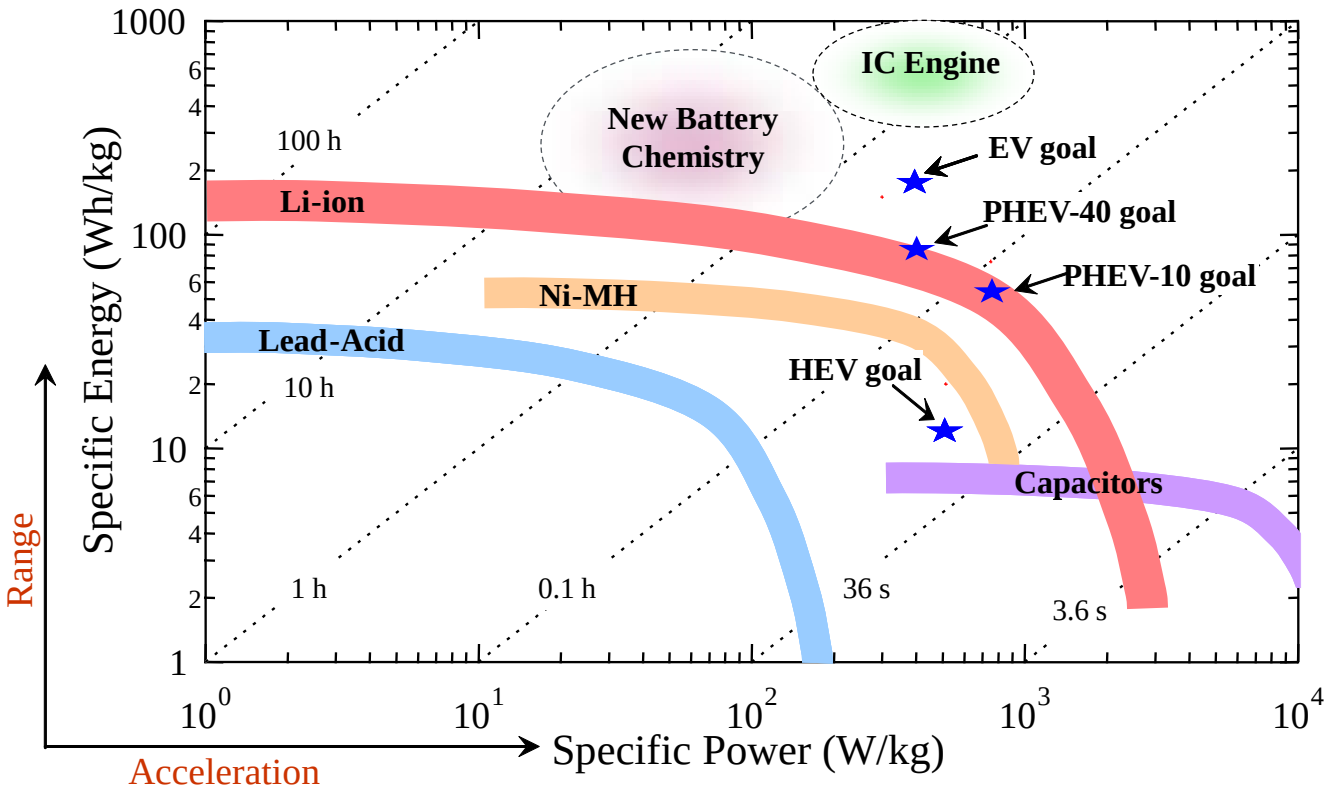
2009 Status: $8000-$12,000 for a PHEV 40-mile range battery

2009 Status: Current cost of the electric traction system is ~$34/kW

2014 PHEV: Battery that has a 40-mile all-electric range and cost $3,400

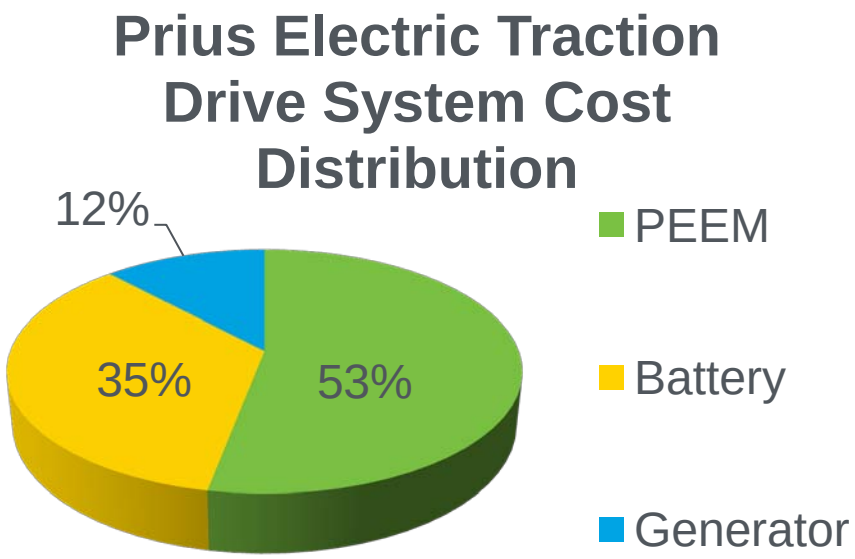
2015 PEEM: Cost for electric traction system no greater than $12/kW peak by 2015

Relative Performance of Various Electrochemical Energy Storage Devices



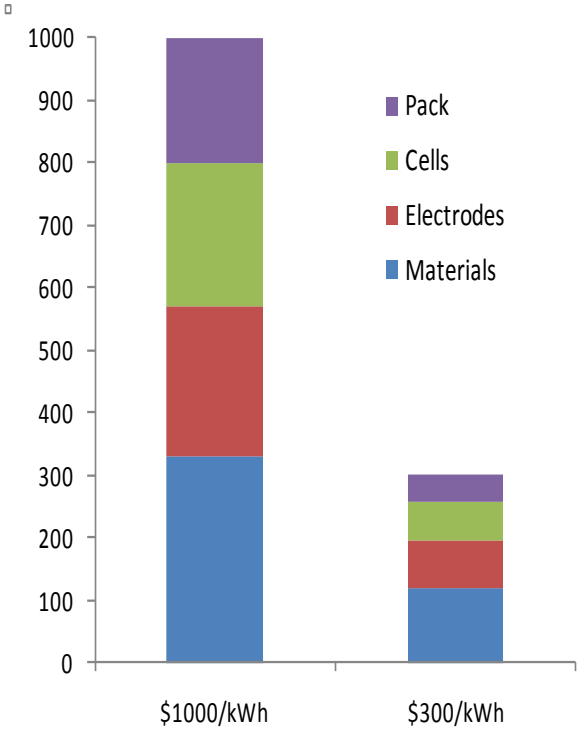
Source: Product Data Sheets

Hybrid-Electric Systems



While Power Electronics & Electric Machine (PEEM) costs predominate in a HEV traction drive system, increased battery size in PHEV configurations will necessitate increased focus on battery cost reduction.

Battery Cost Reduction



- Cell materials & fabrication represents about 3/4 the cost for PHEV batteries
- For significant cost reduction, new materials with increased energy density are needed to reduce:
  - material needs
  - cell count, and
  - cell/pack hardware

Fuel Cells — *Where are we today?*

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Fuel Cells for Stationary Power, Auxiliary Power, and Specialty Vehicles

The largest markets for fuel cells today are in stationary power, portable power, auxiliary power units, and forklifts.

~75,000 fuel cells have been shipped worldwide.

~24,000 fuel cells were shipped in 2009 (> 40% increase over 2008).

Fuel cells can be a cost-competitive option for critical-load facilities, backup power, and forklifts.

Production & Delivery of Hydrogen

In the U.S., there are currently:

- *~9 million metric tons of H_2 produced annually*
- *> 1200 miles of H_2 pipelines*

Fuel Cells for Transportation

In the U.S., there are currently:

- *> 200 fuel cell vehicles*
- *> 20 fuel cell buses*
- *~ 60 fueling stations*

Several manufacturers—including Toyota, Honda, Hyundai, Daimler, GM, and Proterra (buses) —have announced plans to commercialize vehicles by 2015.

GM

What is the payoff? -- 2030

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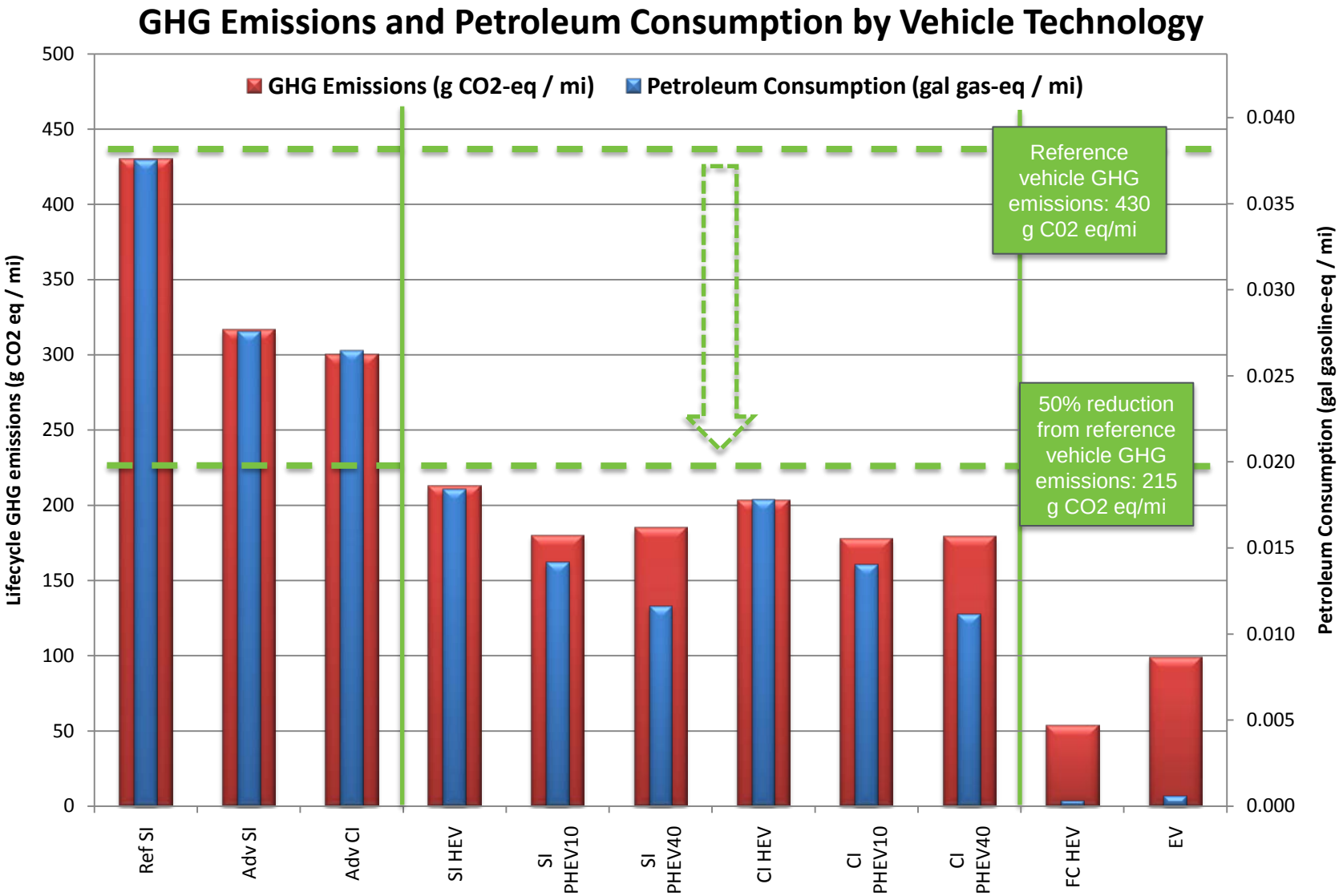
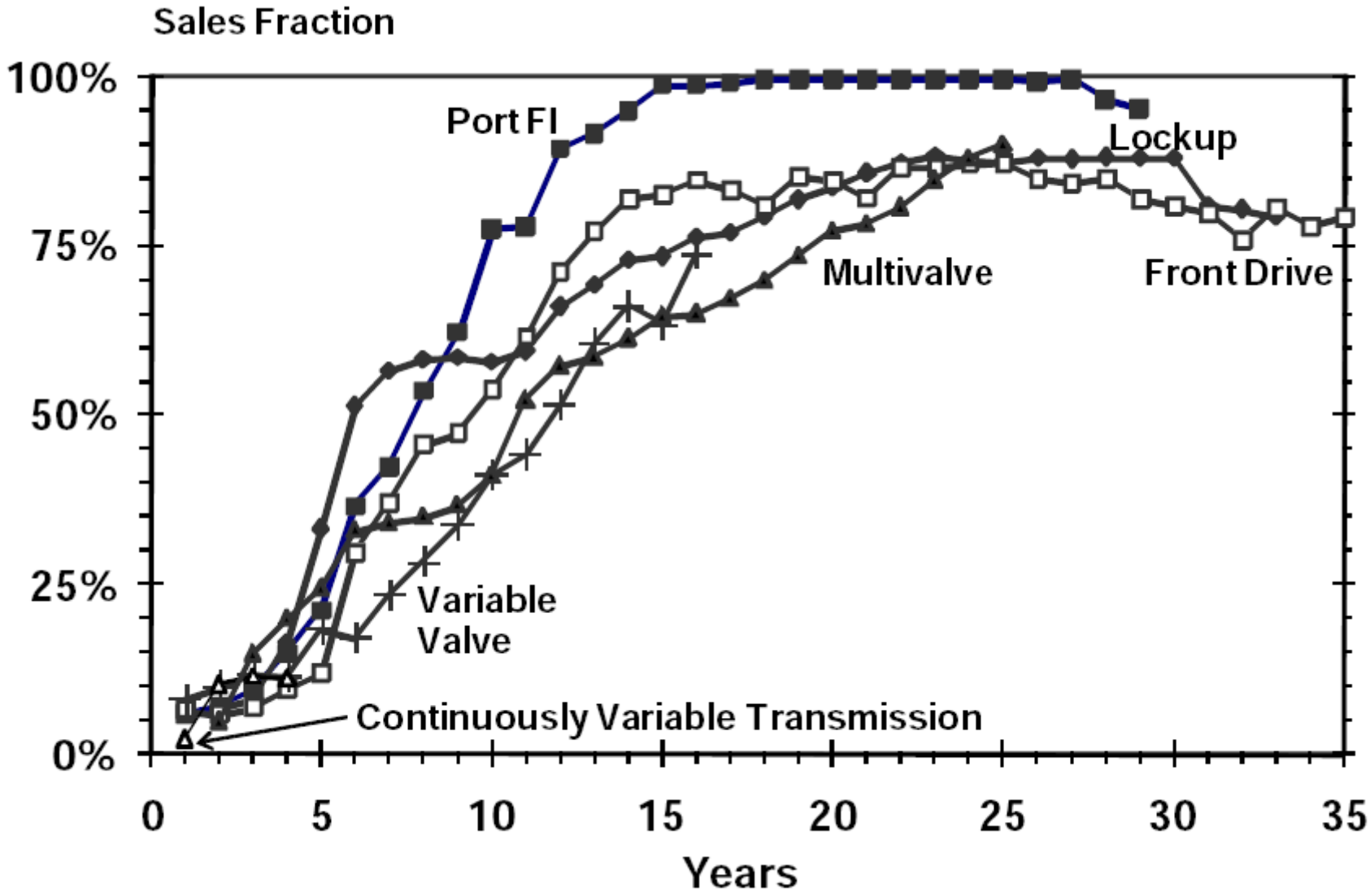
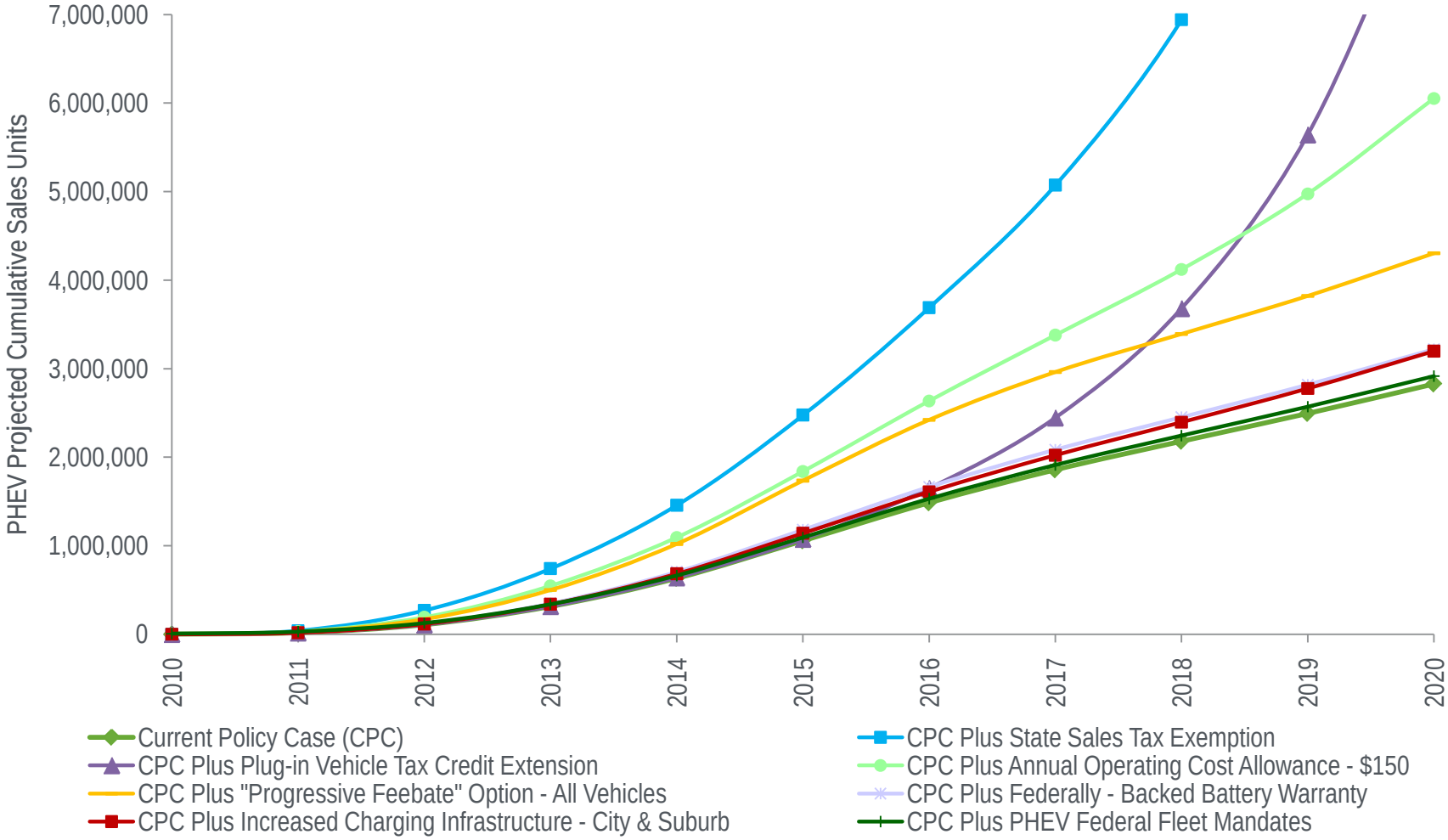


Car Technology Penetration Years after First Significant Use



PHEV Market Introduction Study



PHEV Market Introduction Study. ORNL, Sentech Inc, and University of Michigan Transportation Research Institute (UMTRI).

Prius sales are related to the price of gasoline.

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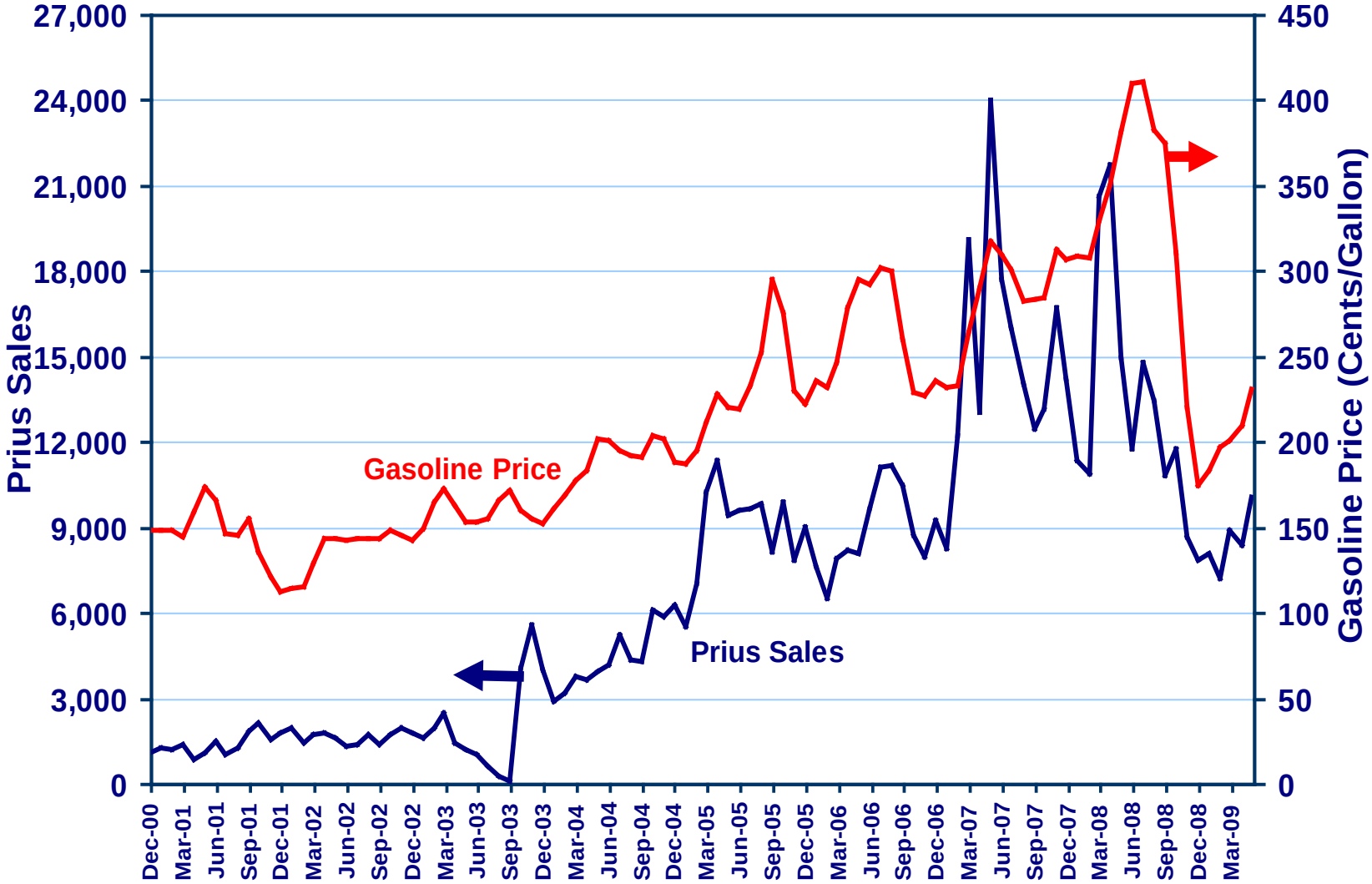

Investments

Fiscal Year 2010 Budget

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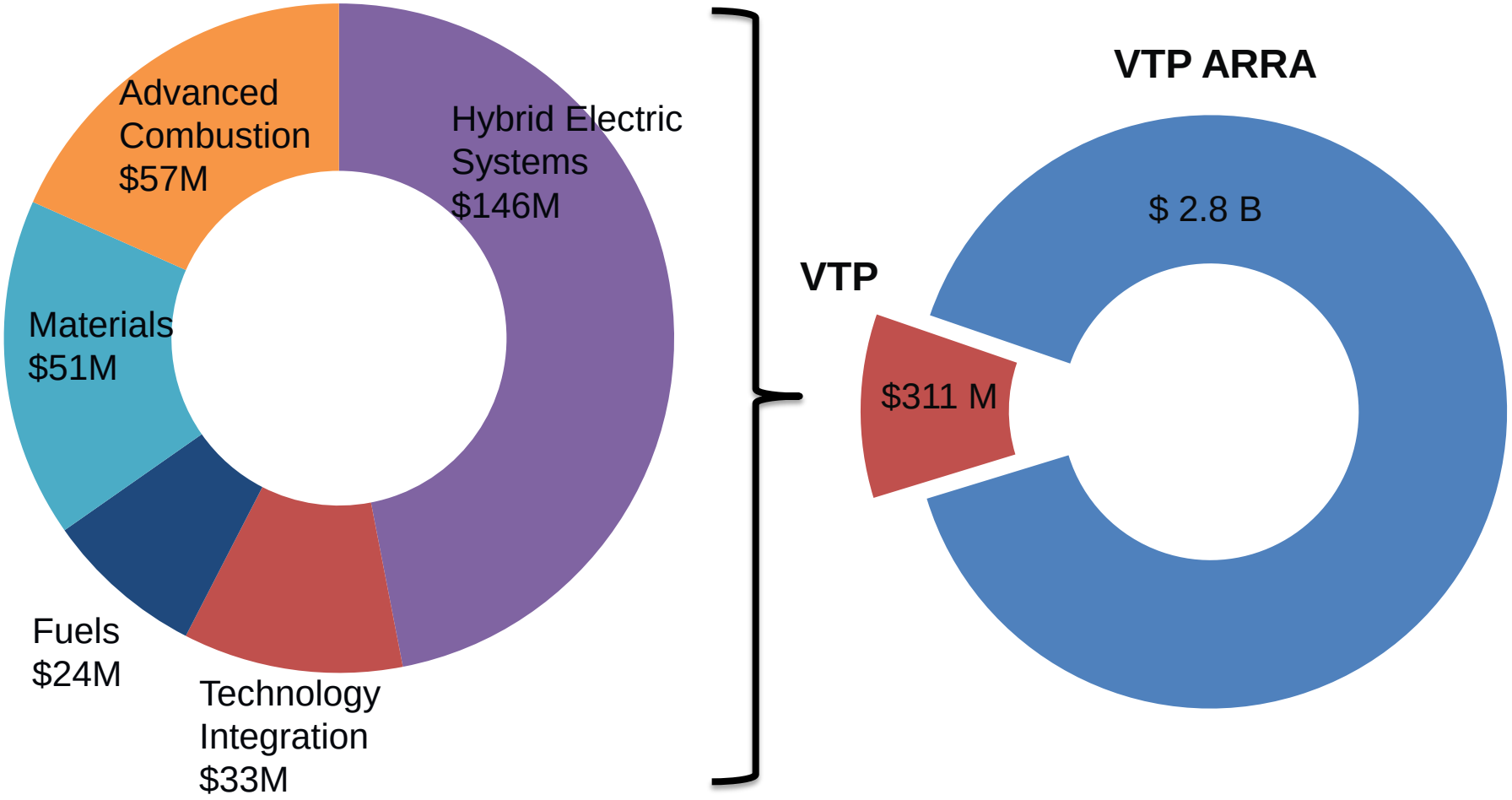
Vehicle Technologies
Total – $311 M

Vehicle Technologies and ARRA
Total – $3.1 B



Materials and Energy Storage 2010 Budgets

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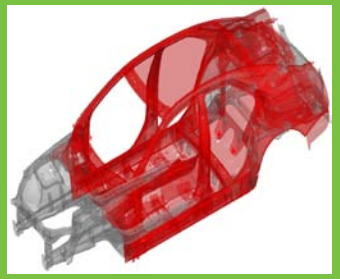
$44 M investment in **Power Electronics and Electric Machines** to accelerate development of lower cost, compact, highly efficient electronic power management systems and electric motors for electric drive vehicles.

$76.3 M investment in **Energy Storage** for high performance, **lower cost** energy storage devices, including **high capacity** lithium-ion batteries and capacitors.

$22.3 M investment in **Vehicle and Systems Simulation and Testing** for modeling and field evaluation of hybrid, plug-hybrid, and electric vehicles, and development of the infrastructure to support large numbers of electric vehicles charged from the utility grids.

$30.7 M investment in **Lightweight Materials Technology** to **accelerate** the introduction of light weight materials and structures for vehicles in order to **reduce transportation fuel consumption** and greenhouse gas emissions.



$13 M investment in **Propulsion Material Technology** to develop **high performance materials** for automotive engine components, in order to improved the **performance, efficiency, and emissions** of internal combustion engines.

$5.7 M investment in **High Temperature Materials Laboratory** to make available to researchers a set of **unique analytical tools** and techniques for characterizing the **behavior of materials at high temperatures** and stresses.

Vehicle Technologies Recovery Act Funding – 2.8 Billion

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$1.5 Billion to accelerate the manufacturing and deployment of the next generation of **U.S. batteries**

$500 Million for **Electric-drive Components Manufacturing**

$400 Million for **Transportation Electrification**

Recovery Act money is funding **48 new projects** in advanced battery and electric drive components manufacturing and electric drive vehicle deployment in over **20 states**: Directly resulting in the creation **tens of thousands of manufacturing jobs** in the U.S. battery and auto industries

$300 Million for **Clean Cities**

The Recovery Act funding for state and local governments, and transit authorities will expand the nation's fleet of clean, sustainable vehicles and the fueling infrastructure necessary to support them.

$100 Million for **SuperTruck and Advanced Combustion R&D**

Heavy-duty trucks are emphasized because they rapidly adopt new technologies and account for 20% of the fuel consumed in the United States.

Thank you

www.annualmeritreview.energy.gov/

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