



# Hitachi Climate Change Forum

## Electric Vehicle Technologies

March 5, 2009

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Toyota Motor North America, Inc.

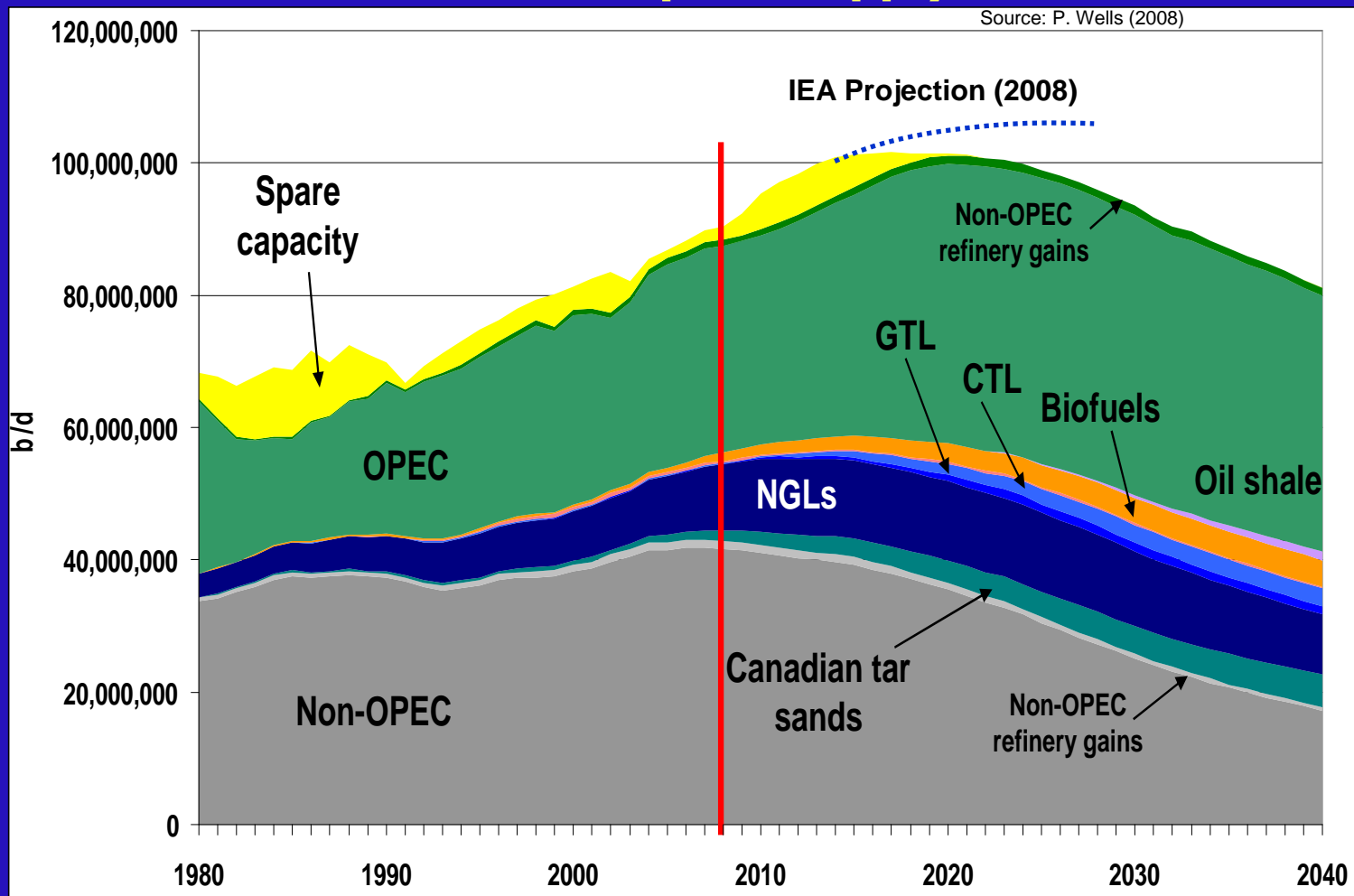


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# Need for Fuel Diversification

## Future Liquids Supply





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## Need for Fuel Diversification



**Increased use of Biofuels**

**Increased use of Electricity**





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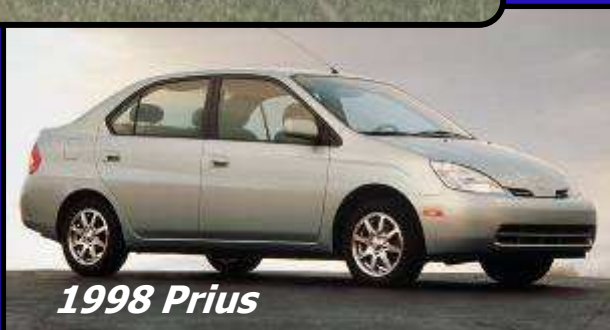


# History of Electrified Toyotas

**1967 S800 Gasoline Turbine Hybrid**



**1998 RAV4-EV**



**1998 Prius**



Toyota Fuel Cell Hybrid Vehicle

**2005 FCHV**



**2008 PHV**



**FT-EV**

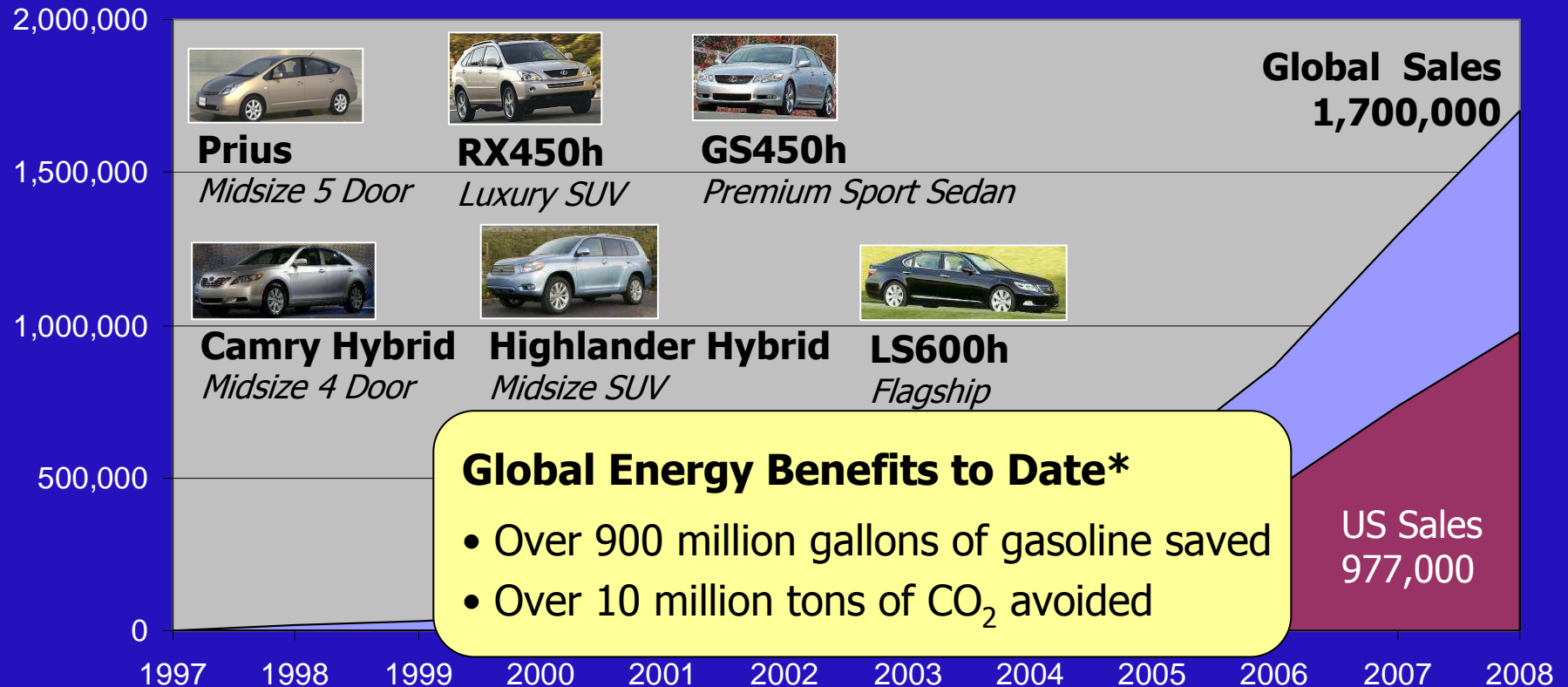


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# 1.7 Million Hybrids Sold & Growing

## Cumulative Hybrid Sales thru December 2008



\*Toyota Estimate

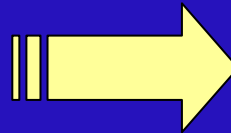
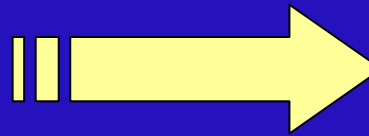


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## Hybrid as a Foundation

- Toyota's Hybrid Synergy Drive is the powertrain foundation for next generation electric technologies
  - Flexibility
  - Reduced development time & cost
  - Lower cost, higher volume potential





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# Toyota's PEV Concepts





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## 2010 PHEV



- Based on the new 2010 Prius
- 500 to be leased to commercial fleets beginning late 2009
- Global program (~150 coming to the US)
  - Study customer use patterns in different markets (US, EU, Japan)
  - Explore public charging infrastructure options (Europe)
- Li-Ion batteries
  - Manufactured by Panasonic EV (Joint venture with Toyota)
- Key Objectives:
  - Confirm battery durability in real-world operation
  - Evaluate suitability of PHEVs in various markets

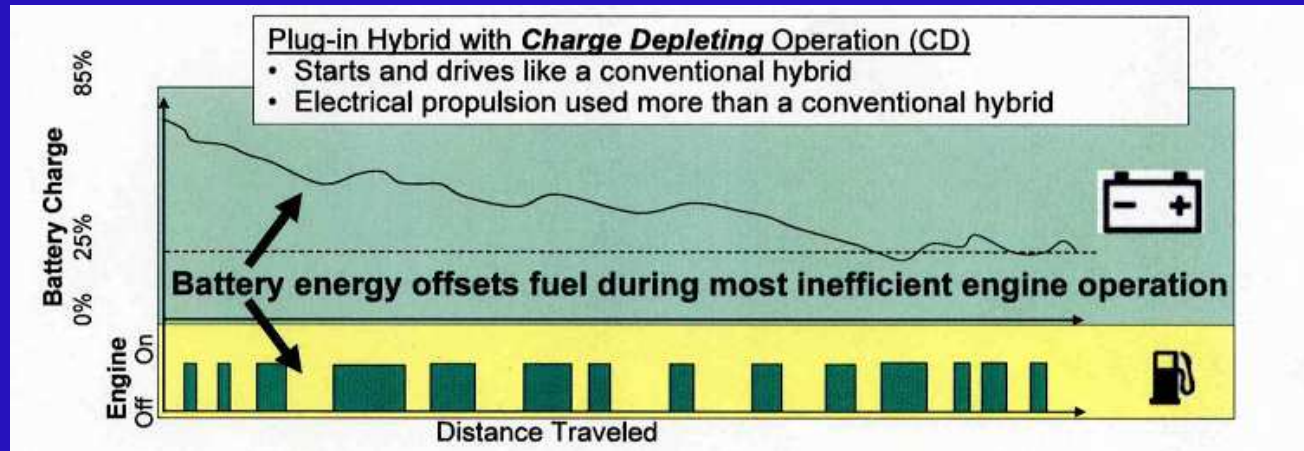


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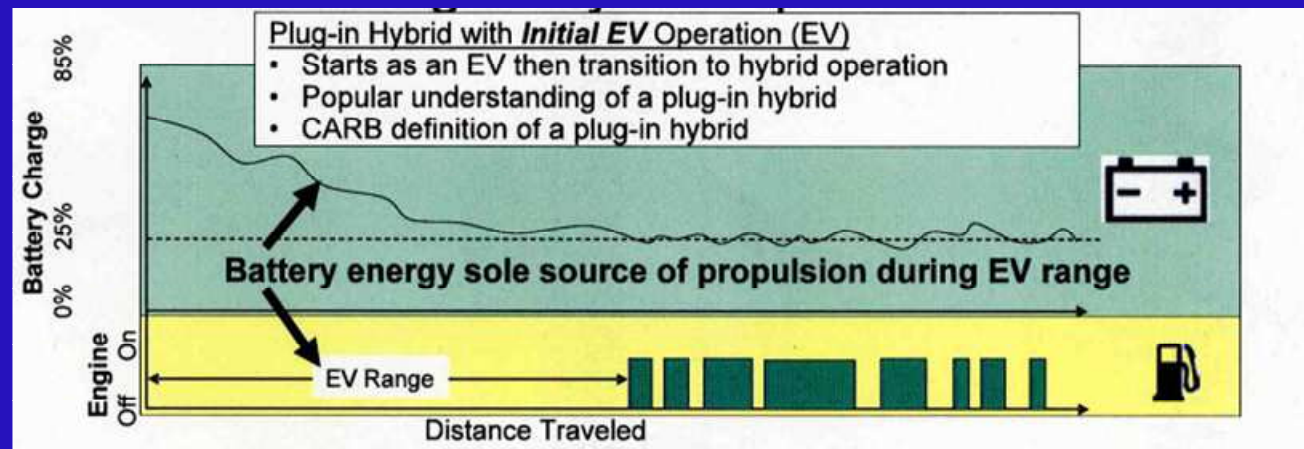


# Toyota PHEV Approach – Blended Strategy

Hybrid Based  
"Blended"  
Strategy



EV Based  
Operational  
Strategy

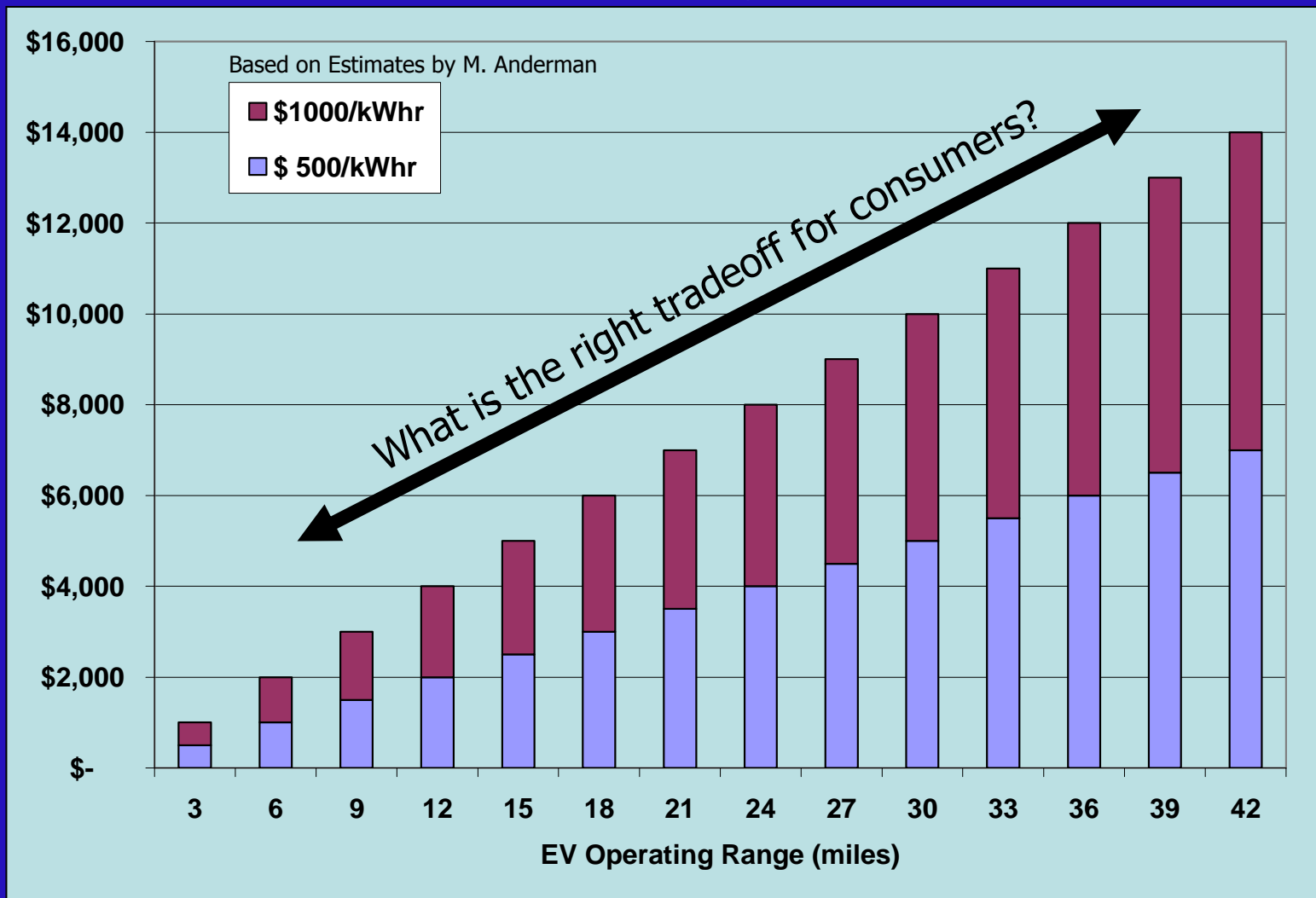




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# How Much EV Range is Optimal?





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# Current PHEV Testing



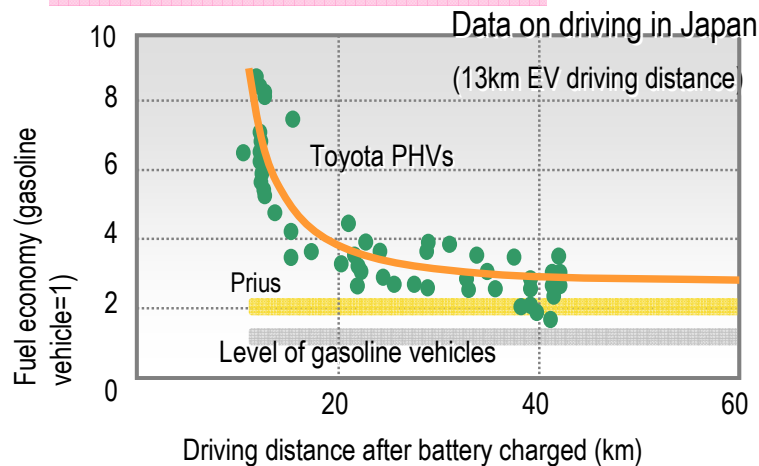
Partner:  
University of California  
Berkeley, Irvine



Partner: EDF

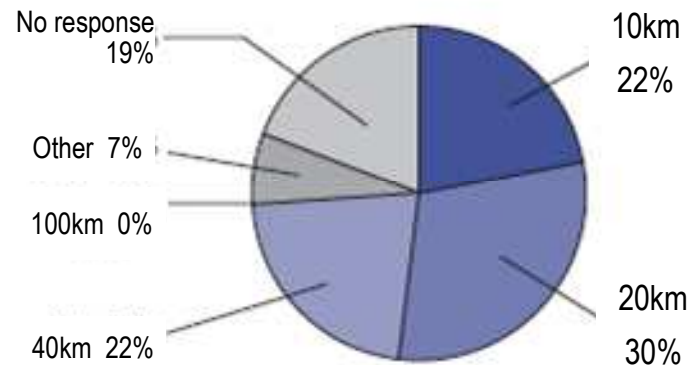


## Fuel Efficiency Improvement



## Expected Values for EV Driving Distance

From driver's feedback



→ Average of 60% fuel efficiency improvement over Prius



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## FT-EV Concept

- Urban commuter battery electric vehicle
- Based on Toyota iQ that is on sale in Japan and EU
- Designed to meet the needs of an urban commuter
- 2012 launch
- Over-night charging on 110 volt household power



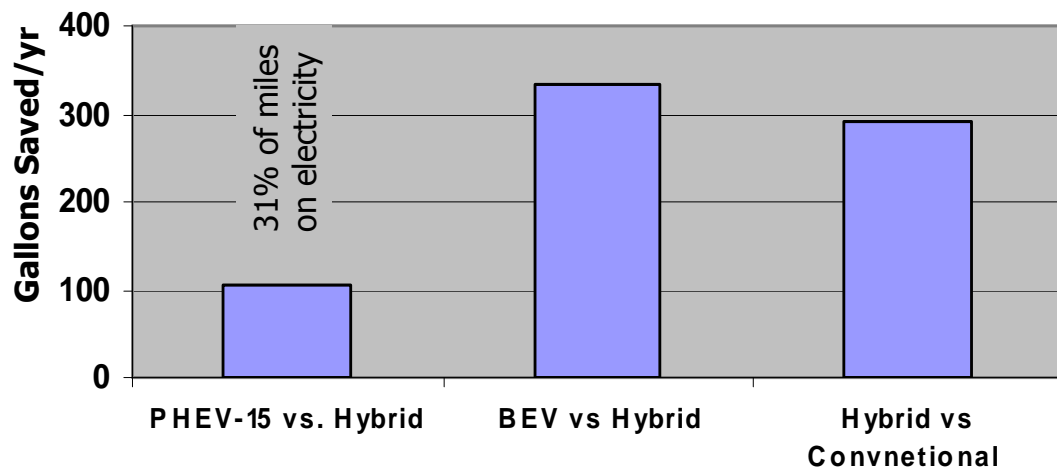


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## Annual Fuel Saving Potential

### ***Fuel Savings***



### Assumptions

- Fuel Economy
  - Conventional Vehicle (CV) - 24 mpg
  - Hybrid - 45mpg (Prius)
  - PHEV on electricity – 3.33 mi/kWh
  - PHEV on gasoline – 45 mpg
  - BEV – 4.0 mi/kWh
- PHV recharged nightly
  - Full electric range used 6 days/wk
- Driven - 15,000 mi/yr

PHEVs and BEVs offer additional fuel savings over hybrids

→ Clear energy security and fuel diversification benefits

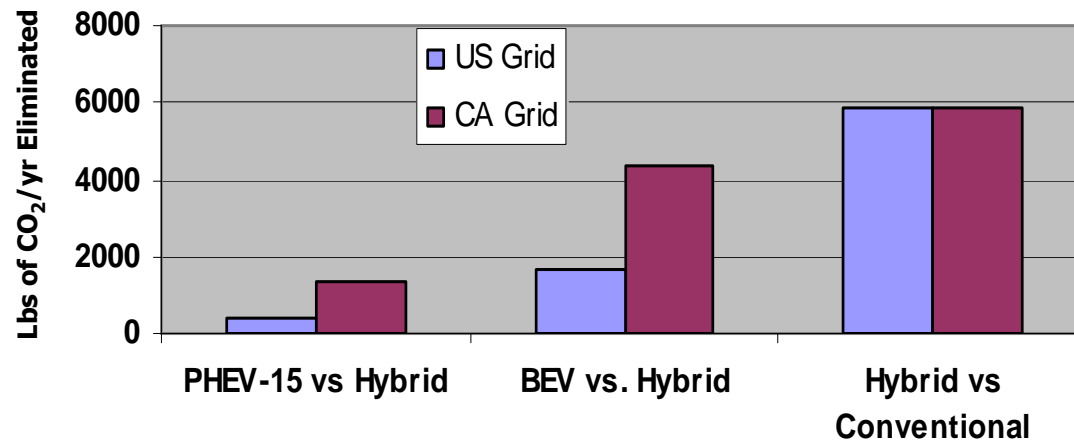


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## Annual CO<sub>2</sub> Savings Potential

### CO<sub>2</sub> Reduction



#### Assumptions

- Those on previous slide
- 1.34 lb-CO<sub>2</sub>/kWh US grid average
- 0.61 lb-CO<sub>2</sub>/kWh CA grid average
- 7.2% Transmission losses
- Electric drive efficiency
  - PHEV 3.33 mi/kWh
  - BEV - 4.0 mi/kWh

CO<sub>2</sub> benefit varies significantly based on source of electricity

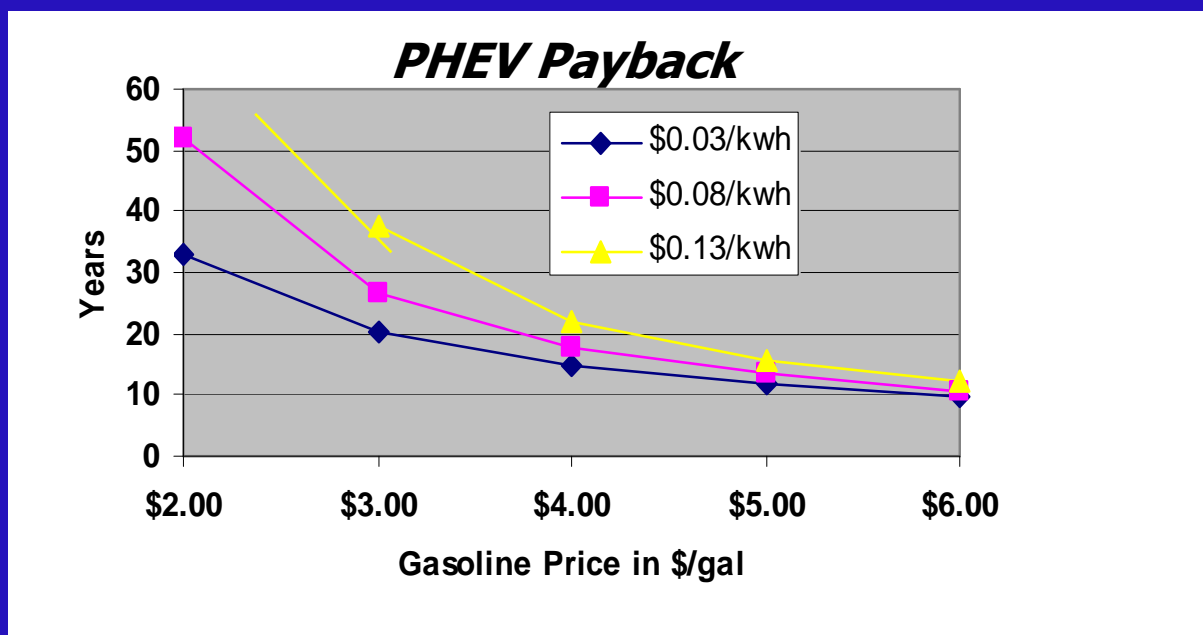
→ "Greening of the grid" is needed to fulfill environmental promise of PEVs



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## PEV Payback Example



### Assumptions

- Those on previous slides
- Prius is the base vehicle
- \$1000/kWh additional battery cost
  - Current DOE estimated battery cost
- Useable battery capacity – 80%
- EV range is linear with battery size
  - Similar PHEV & BEV payback curves

High battery and low gasoline prices result in long payback periods  
→ Low gasoline price makes PHV economics challenging



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## The Electrified Vehicle Challenge

### 1. Batteries – Li-Ion

- High cost - ~\$1000 / kW-hr
- Durability – 8yrs & 120k miles (minimum)
- High and low temperature performance
- Energy density – packaging, weight, range

### 2. Charging infrastructure – residential

- ~50% of households have ability to charge vehicle
- Need for “smart metering”

### 3. Power grid – “Greener” electricity

- Move to nuclear, renewables or add sequestration to coal plants
  - if non-CCS coal → little CO<sub>2</sub> benefit

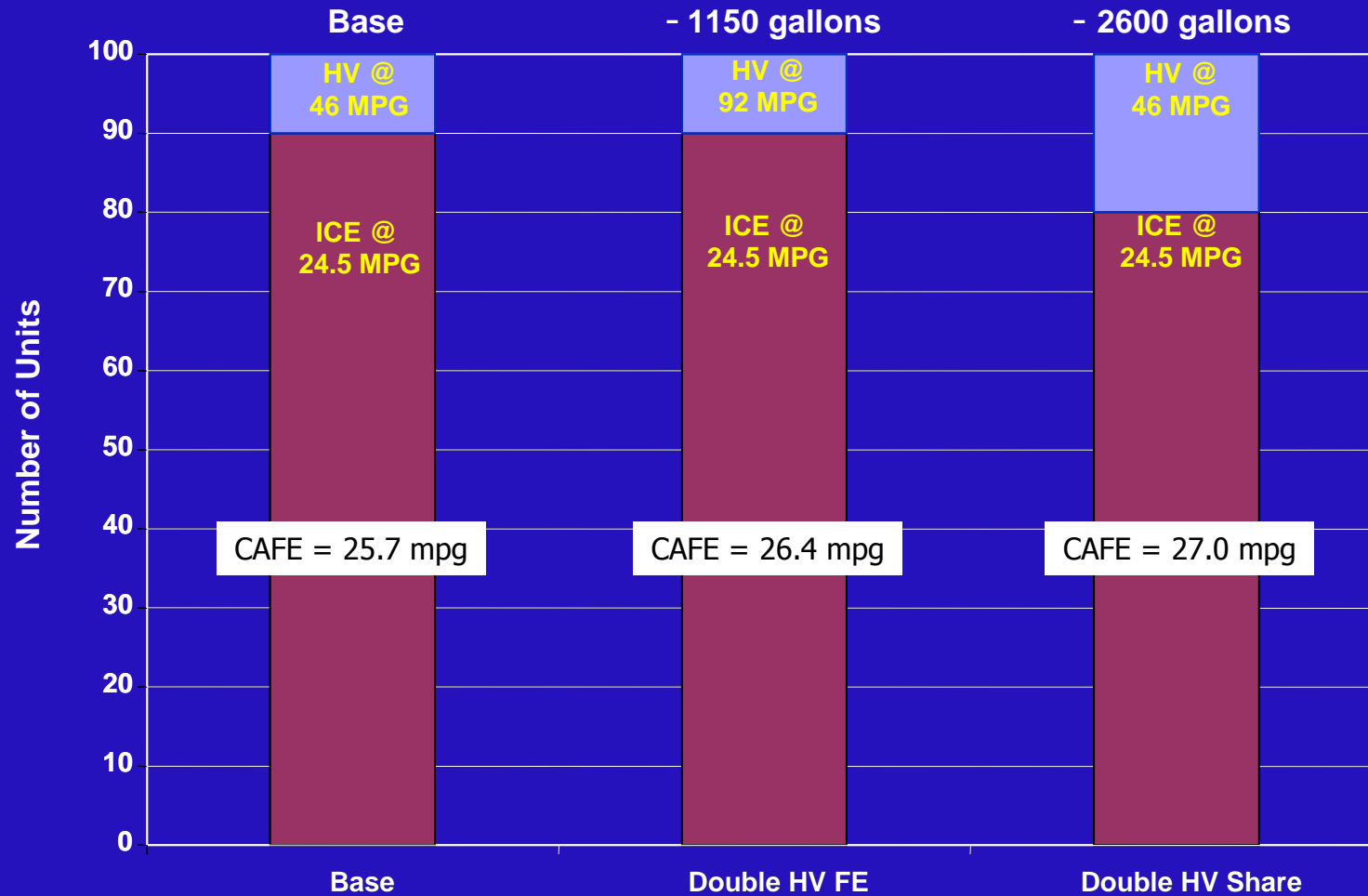




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# Benefit of Using What We Already Have



Assumes 15,000 miles per year per vehicle



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## Conclusions

- Fuel diversification is inevitable
- Hybrid is the cornerstone for future vehicle technologies at Toyota – PHEV, BEV & Fuel Cell are evolutions
- Durability, cost and infrastructure are challenges for all electric vehicle technologies
- Without “green” fuels, the environmental benefit (GHG reduction) of these technologies will be modest at best
- Deploying new technology takes time
- “Regular” hybrids still offer huge opportunity
- Mass market appeal is needed to make a difference



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***Thank You!***

