

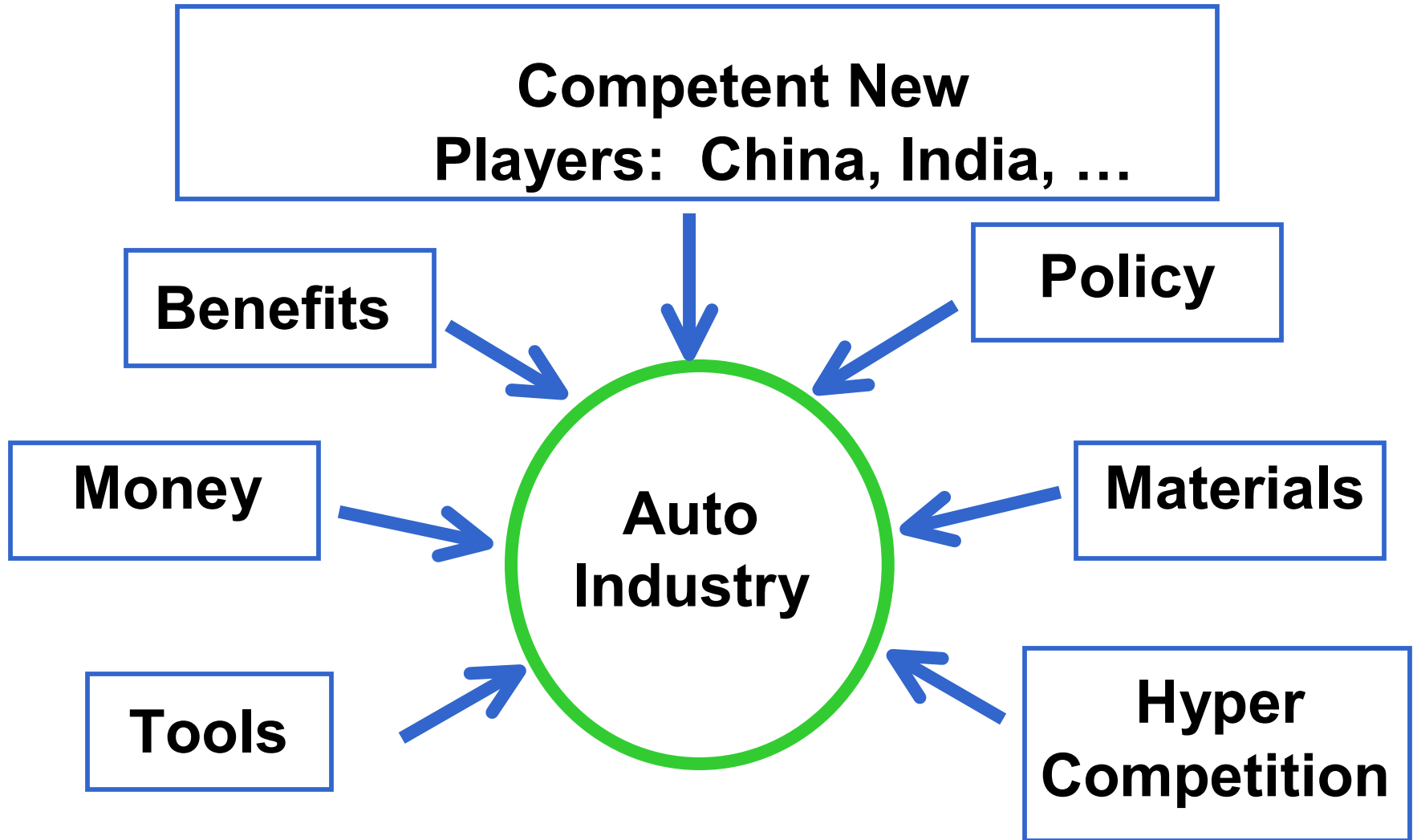
The Incredible Speed of Change in Powertrains & Fuels.

David E. Cole
Chairman
Center for Automotive Research (CAR)

Foundation for American Communication

*Detroit Auto Seminar
January 10, 2009*

The Perfect Storm



Key Contemporary Issues

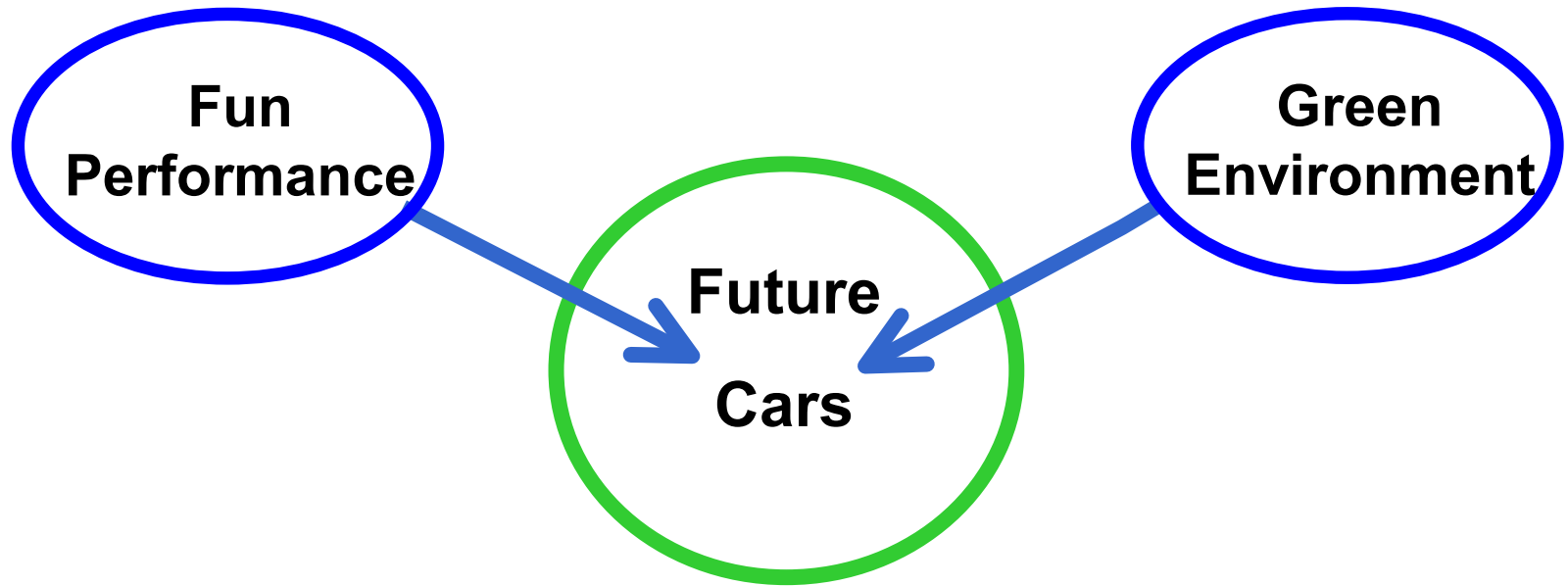
▲ Energy

▲ Policy

▲ Money

Auto Technology

At the edge of a revolution?

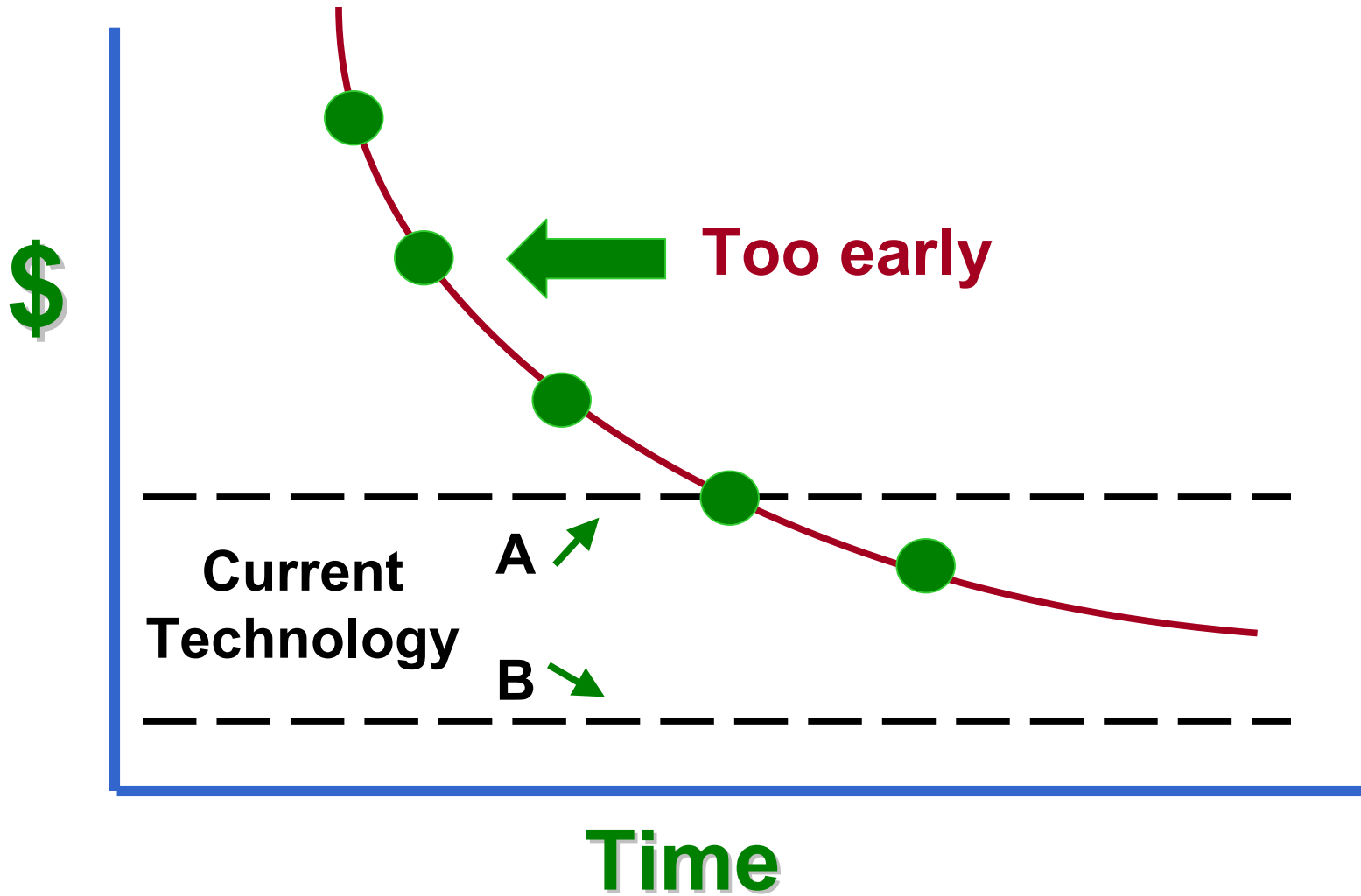


Future Power Plants

- **Gasoline**
- **Diesel**
- **Hybrid**
- **Fuel Cell**

The Answer – ?

Technological Progress—When to Commercialize



POWER TECHNOLOGY COMPARISON CHART

TECHNOLOGY OPTIONS / COMPARISON PARAMETERS	ADVANCED GASOLINE	CLEAN DIESEL	HYBRID PARALLEL NON-GRID	PLUG-IN GRID BASED HY-BRID
Cost	+\$1,000	+\$3,000	+\$4,000 to +\$6,000	?
Fuel Economy	+20%	+30%	+20% to +30% (with diesel +50%)	?

“BOTTOM LINE”

- ▲ Not enough knowledge to pick winners and losers
- ▲ Different strategies for different companies
- ▲ Alliances necessary to overcome challenges
- ▲ Government incentives required...ultimately consumers decide

**Coming Fast – Plug-in,
Series Hybrids
and/or
Extended Range
Electric Vehicles**

- **Petroleum**
- **Bio**
- **Hydrogen**

The Answer – ?

Future Gasoline Price –

\$ 1.50 – \$ 5.00 /gallon

**Look at What has
Happened in the Past
3 Months –**

Old Carbon Fuels Will Continue to be Used if they are Economic

**Improved Efficiency and New
Carbon Fuels – Can Slow Growth of Old
CO₂ and Keep Expensive Old Carbon
Fuels From Being Extracted.**

A Quantum Leap

Chevrolet Volt Using E-85

About 400 mpg of Gasoline.

2 Key Developments

▲ Lithium Batteries

▲ Cellulosic Bio Fuels

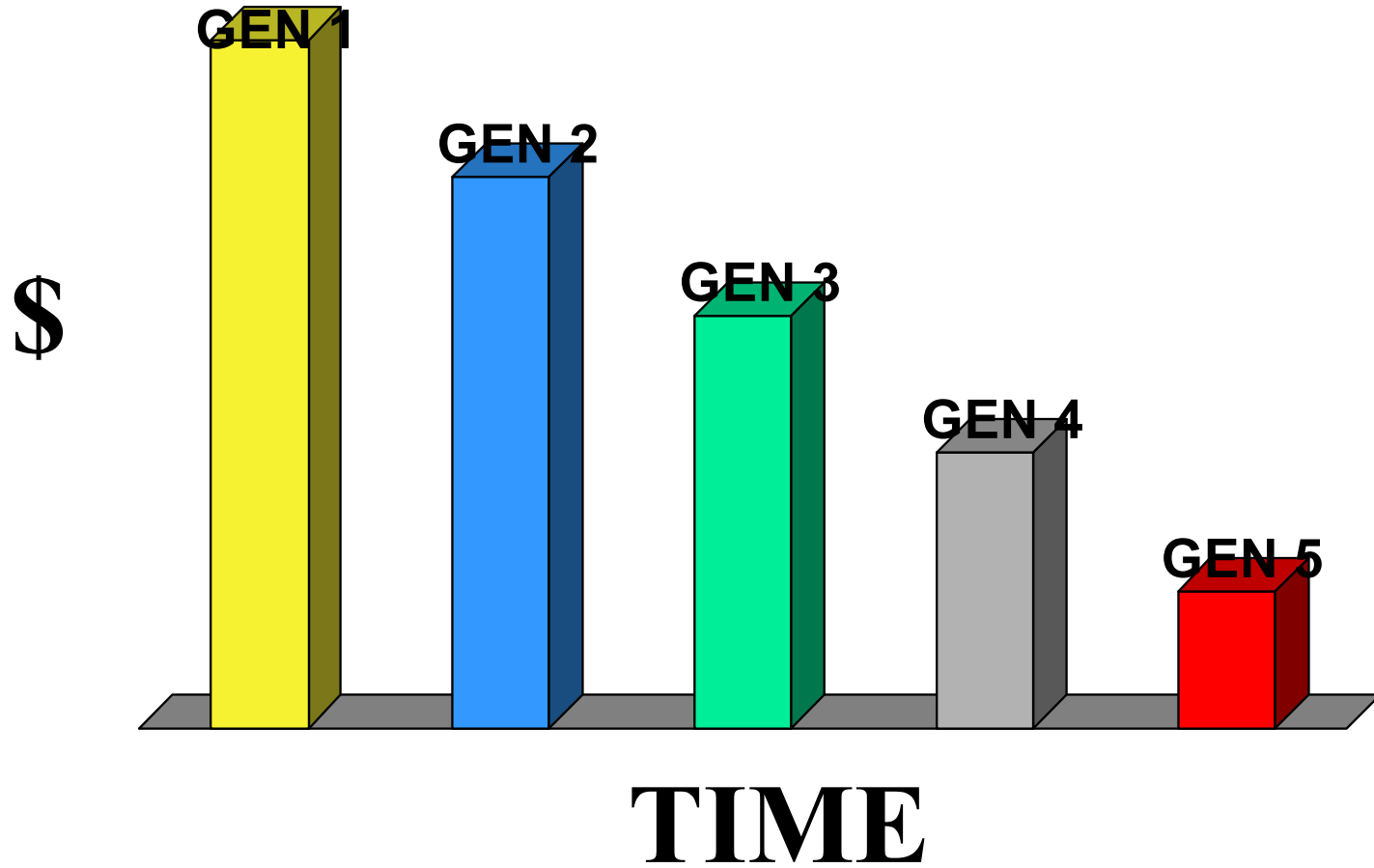
The Invention is Here!

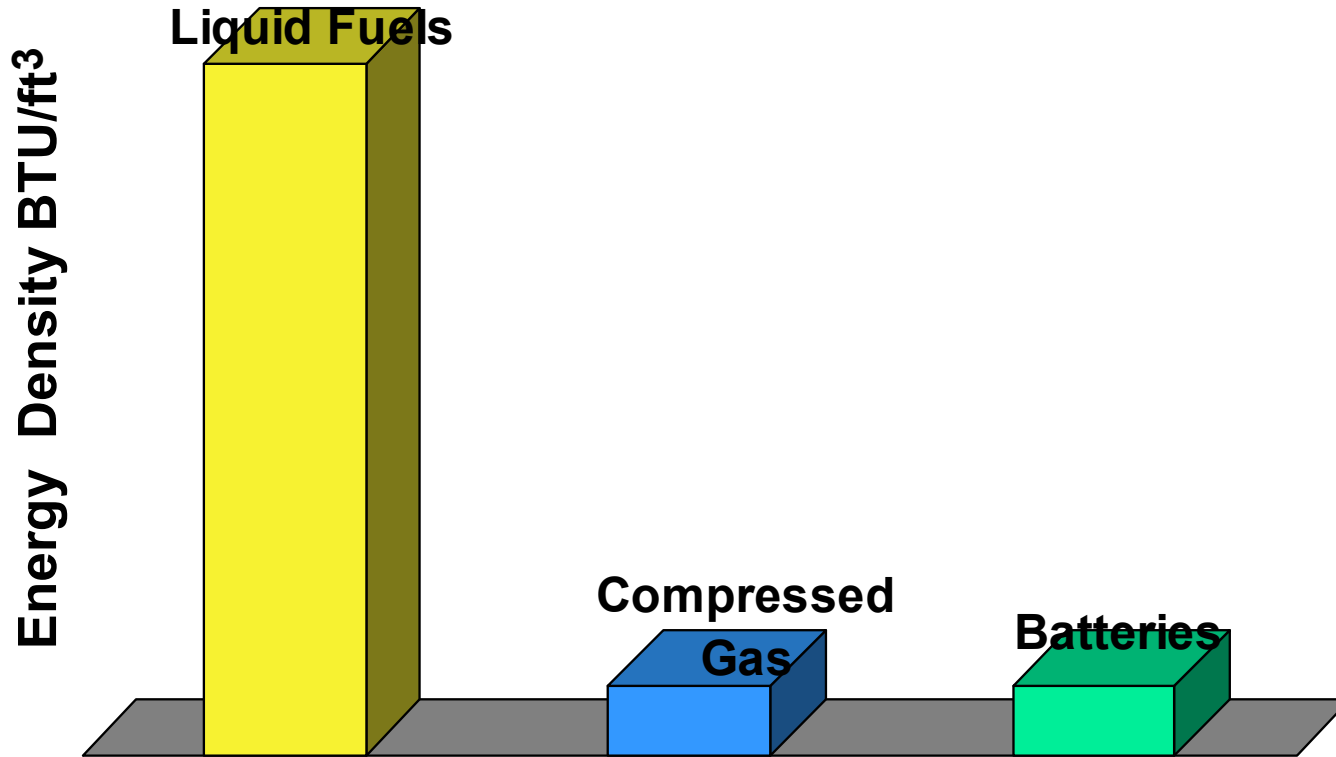
- ▲ Lower Heating Value
- ▲ 2010 - 2015 - \$1.00/gal?
- ▲ Energy Balance > 6
- ▲ Cost Increase for E-85 Vehicle < \$100
- ▲ Global Impact
- ▲ Development not Invention

- ▲ 4 x Performance Lead Acid
- ▲ Many Chemistries
- ▲ Heat a Problem
- ▲ Key to Plug-in Hybrids
- ▲ Battery Life - ?
- ▲ Development not Invention

▲ **Manufacturing**

▲ **Materials**





Life After the Car: The Grid!

Grid:

Significant Storage Capacity is Required

- **Off Peak Power**
- **Solar**
- **Wind**
- **?**

New Business Model

Home Electric Bills

- ▲ House Electricity**
- ▲ Car Battery Charge**
- ▲ Battery Lease**

Battery Lease

Battery Price - \$5,000

Value After 10 Years - \$2,000

Developments to Watch

- ▲ Vehicle/Infrastructure Integration
- ▲ Auto/Utility Integration

Policy Issues

▲ **CAFE – NO!**

▲ **Floor on Petroleum Prices – YES!**

Climate Change – Divisive Conservation - Collaborative

Future Direction

It's All a Matter of Economics