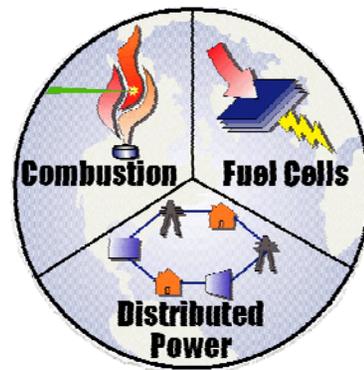


Challenges of Forecasting Vehicle Market Share

Dr. Tim Brown

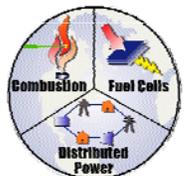
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Outline

- **Competition between species**
- **History of changes to vehicle fleet**
- **Precedent for future vehicles**
- **Ratchet effect**



Yellowstone Park

- Grizzlies dominate and coyotes play a secondary predator role
- What happened in the 1990's when wolves were reintroduced into the park?
- "...grizzly bears... seek out wolf kills and... drive wolves from carcasses" [1]
- "...50% decline in coyote density..." [1]

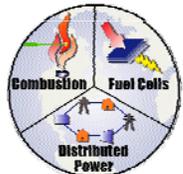
Grizzlies = gasoline vehicles

Coyotes = hybrids

Wolves = other alternative vehicles (PEV, FCV, etc.)



[1] Yellowstone After Wolves, D. Smith et al., Bioscience, 2003

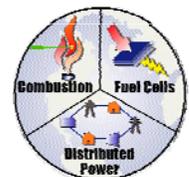


Competition Between Species

Two species (X and Y) competing for the same food source

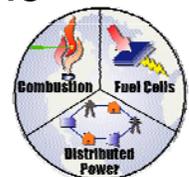
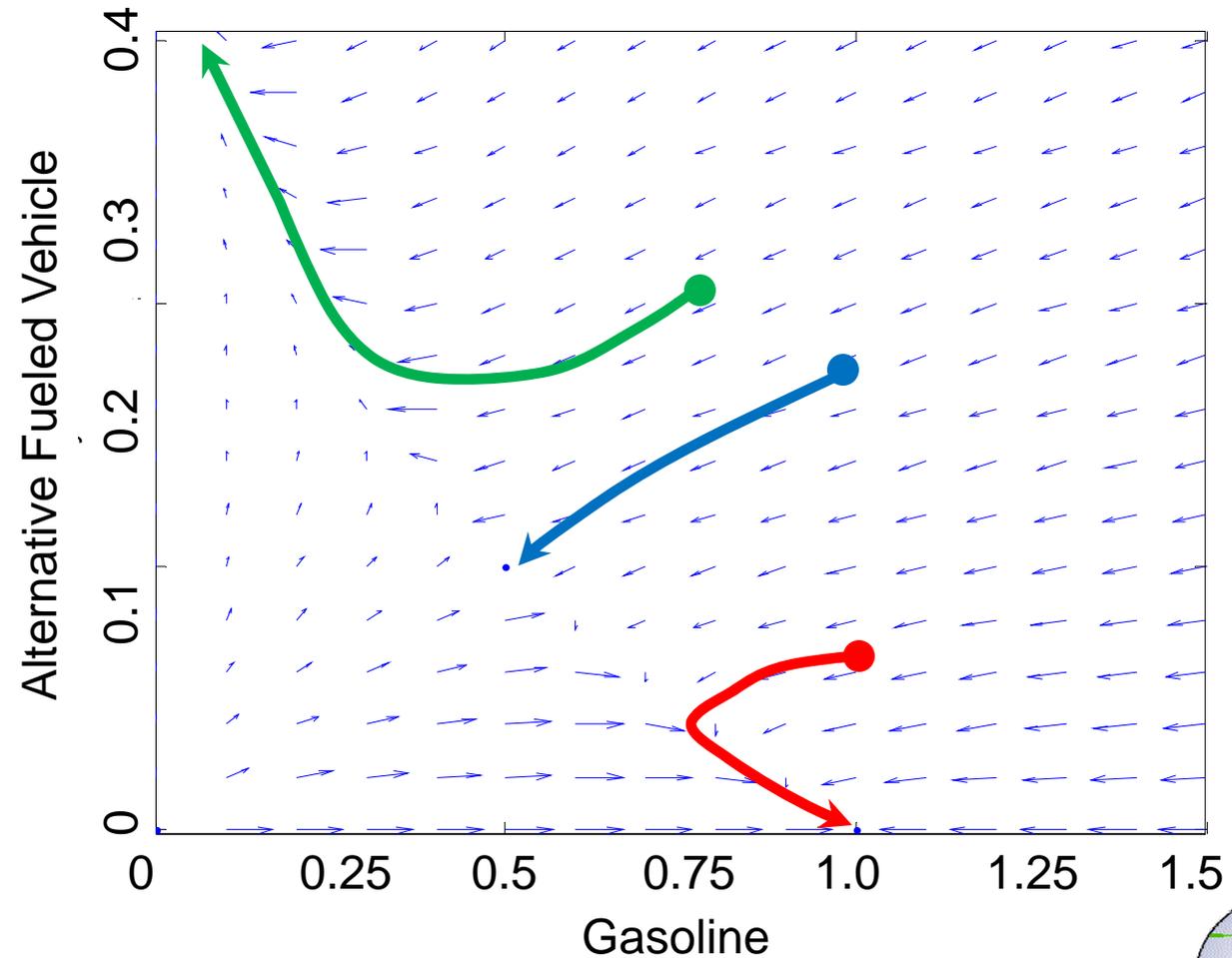
- Or, for example, two types of vehicles competing for the same customers
- C is the carrying capacity of the environment (e.g., total number of cars on the road)
- r is the intrinsic rate of increase of the species (e.g., fleet turnover rate or manufacturing bottleneck)
- α is the competition coefficient between species (e.g., consumer appeal)

$$\frac{dX}{dt} = r_x X \frac{C_x - X - \alpha_{xy} Y}{C_x} \quad \frac{dY}{dt} = r_y Y \frac{C_y - Y - \alpha_{yx} X}{C_y}$$

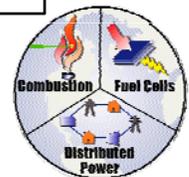
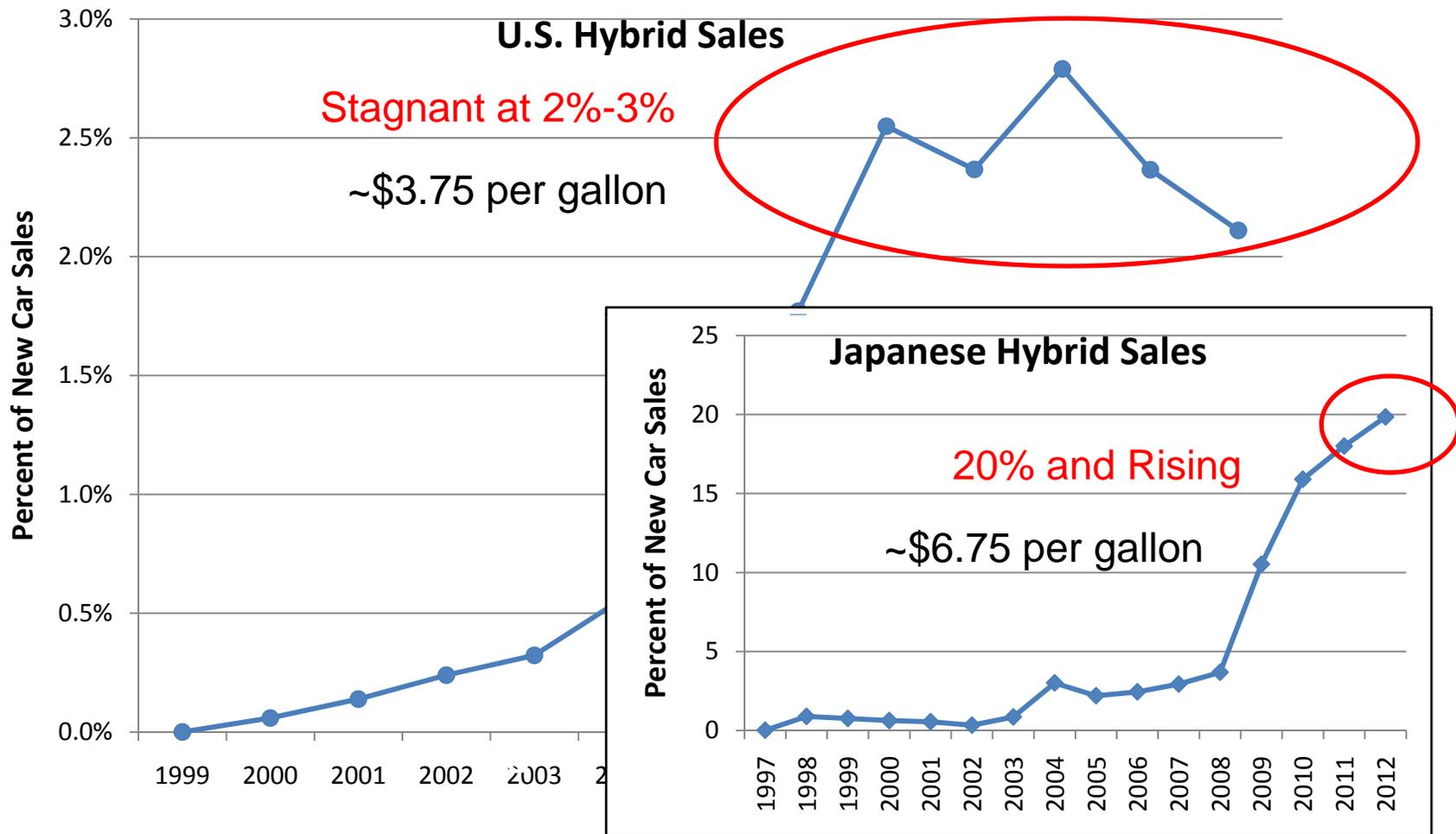


Competition Between Species

Unfortunately, the competition between species, the carrying capacity, and the intrinsic growth rate are impossibly difficult to determine

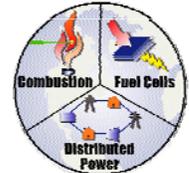
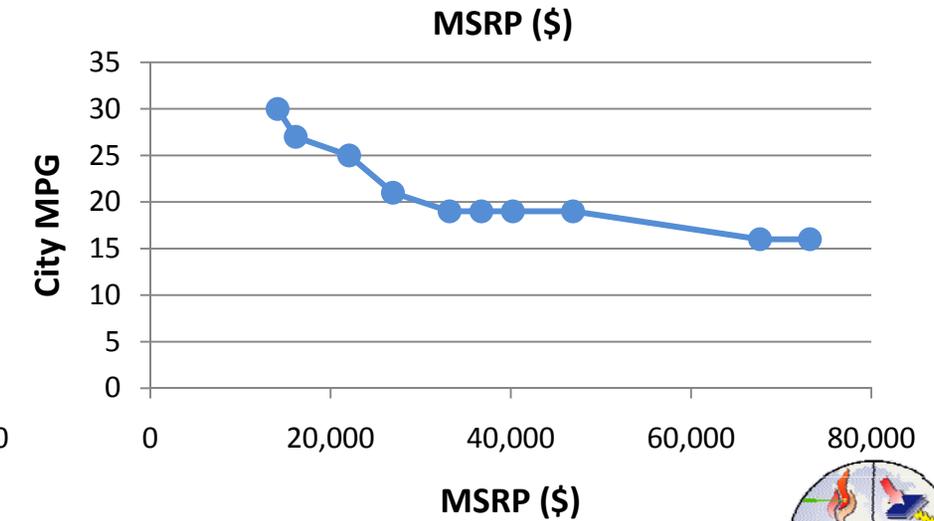
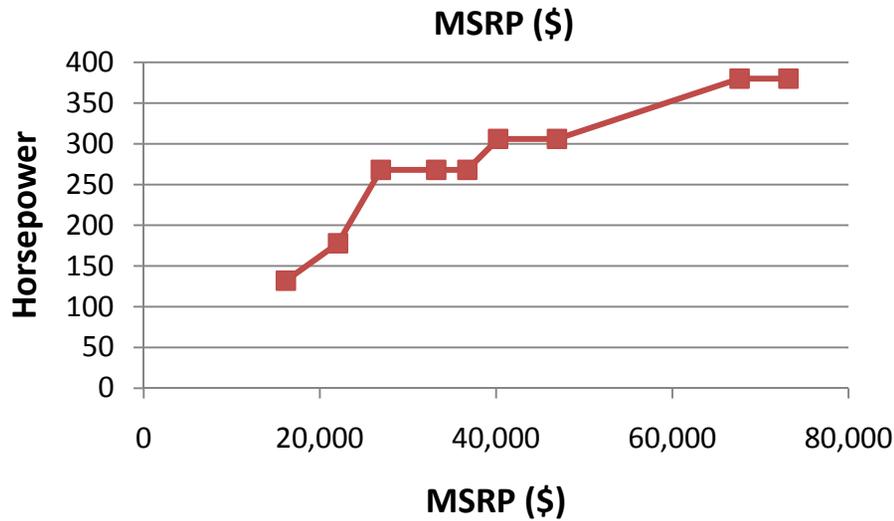
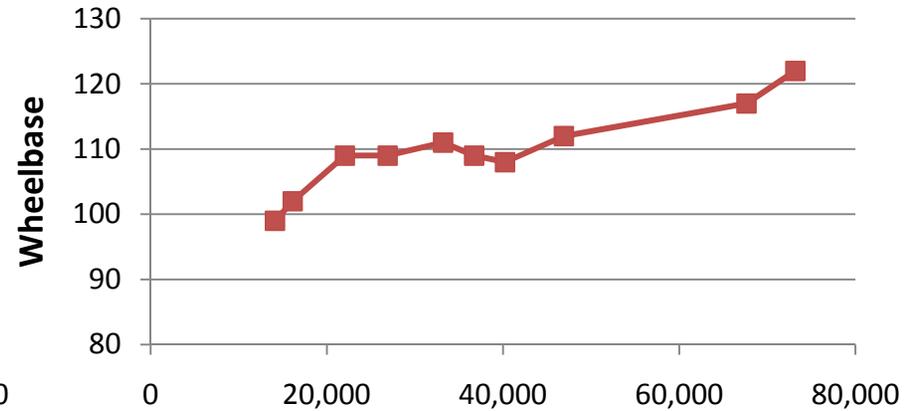
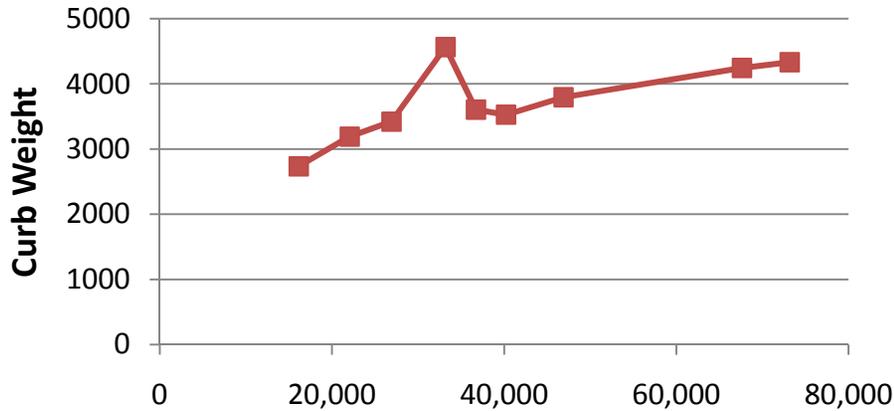


Hybrid Vehicle Sales Trends



Trends for Sedans from One Automaker

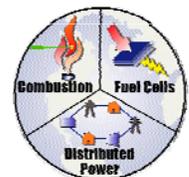
Economics is only one factor...



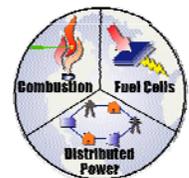
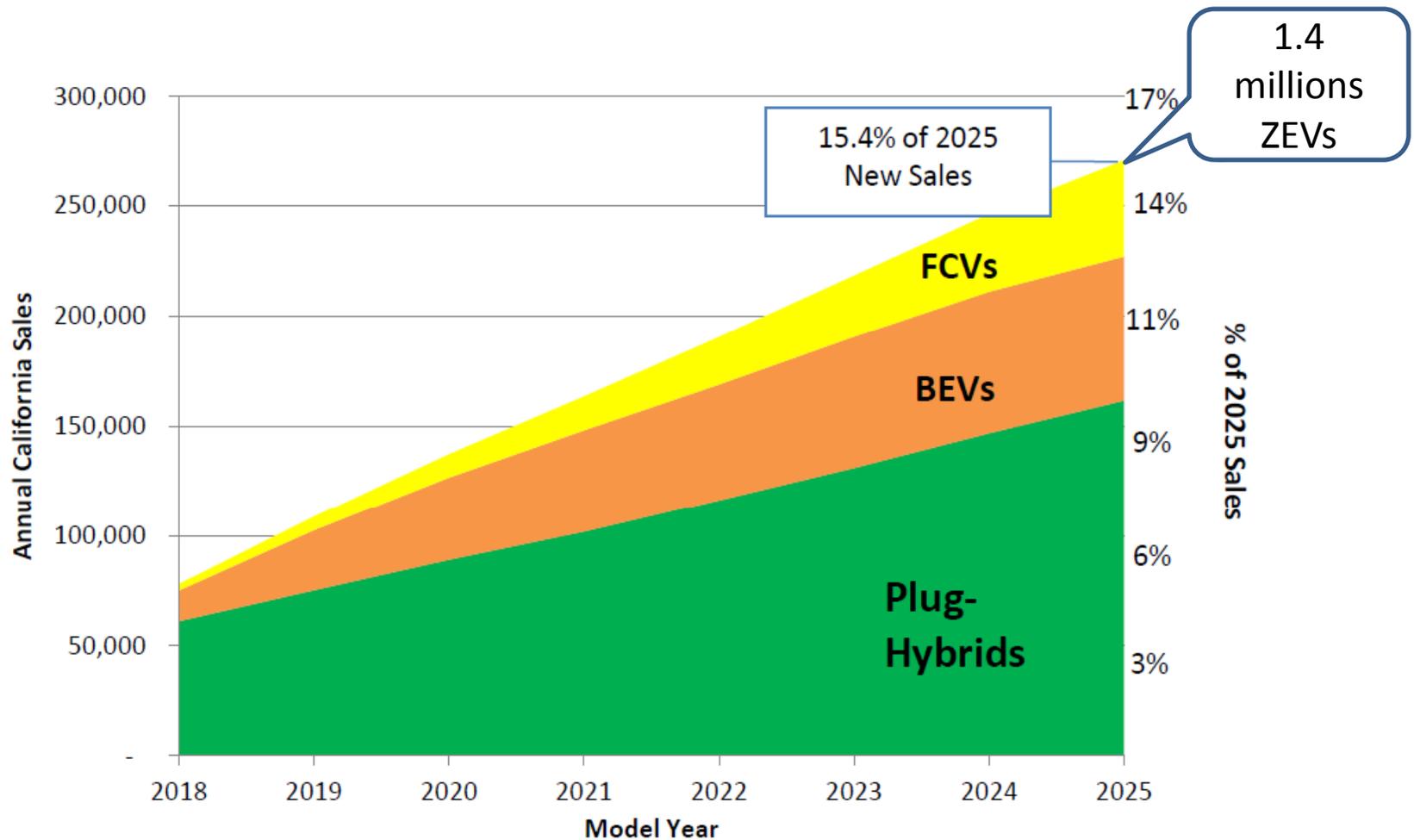
How Can Logic or Math Predict this Result?

Top selling cars in 2011

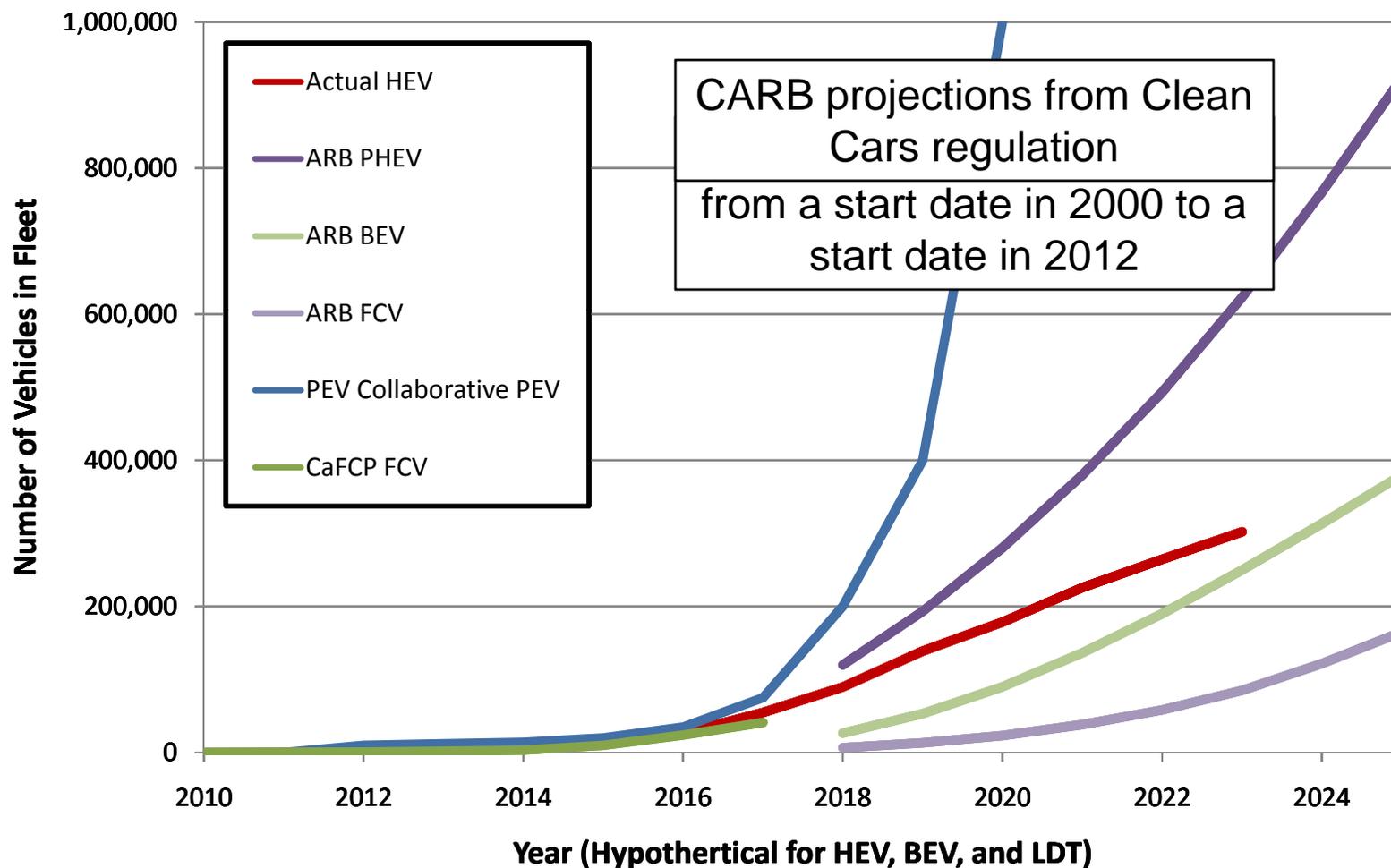
Vehicle	Number Sold	City MPG
Ford F-150	390,661	13
Chevrolet Silverado	319,539	14
Toyota Camry	308,510	20
Nissan Altima	268,981	20
Ford Escape	254,293	21
Ford Fusion	248,067	20
Toyota Corolla	240,259	26
Honda Accord	235,625	20
Chevrolet Cruze	231,732	24
Hyundai Sonata	225,961	22



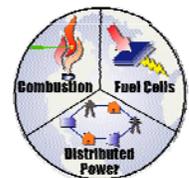
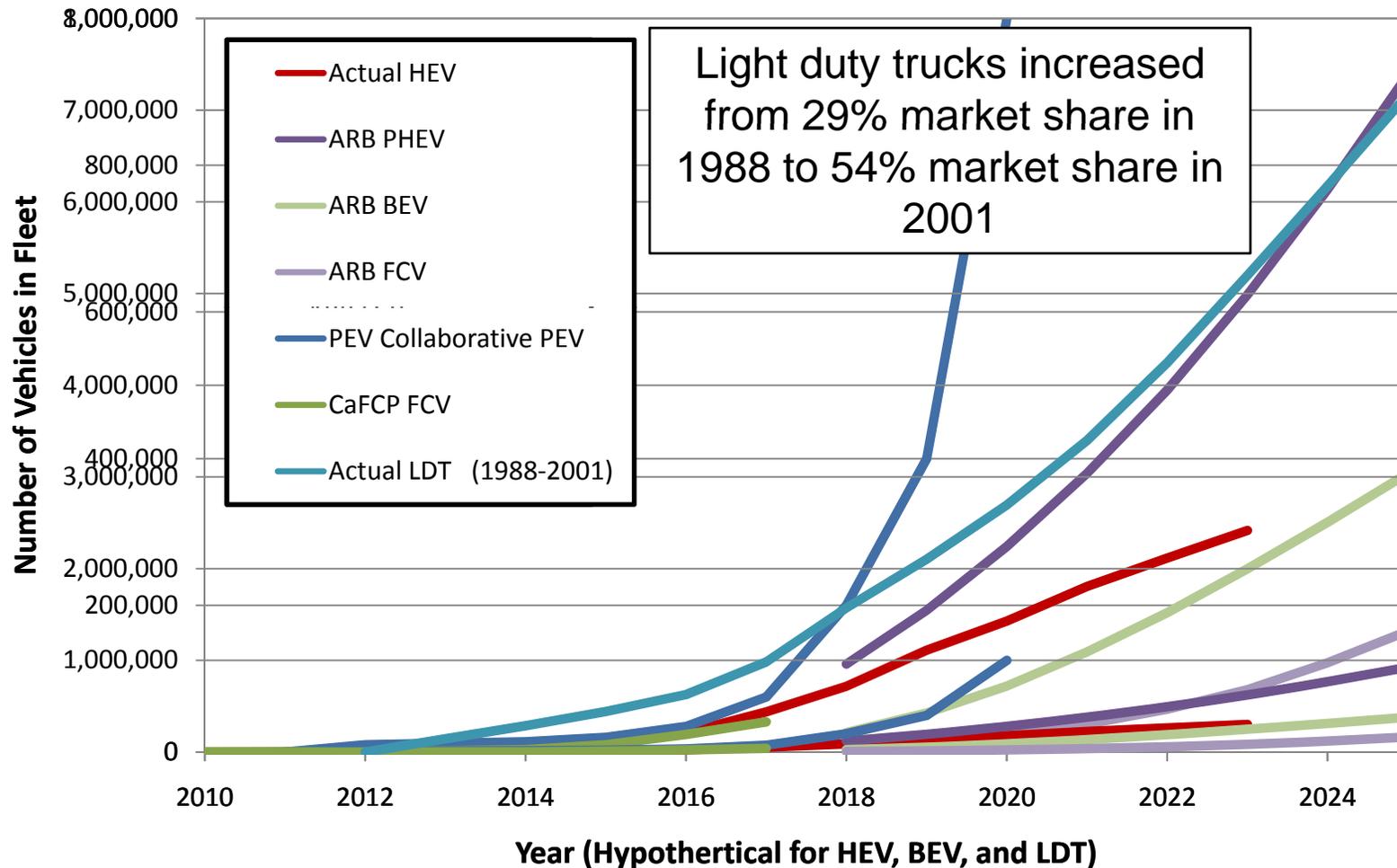
Air Resources Board Vehicle Projections



Enormous Differences in Alternative Vehicle Projections



Precedent for Substantial Parc Change



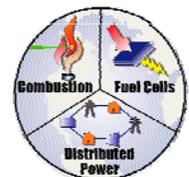
The Ratchet Effect

Will consumers ratchet backwards by:

- Paying more for their vehicles?
- Accepting smaller vehicles?
- Managing with less driving range?
- Contending with different refueling (recharging)?

Perhaps, with the right incentives: —

- Low cost per mile
- Ubiquitous infrastructure
- Seamless integration
- Social awareness
- And...?



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