

**knowing less...**

**...failing more**

**Vinod Khosla**

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Sept, 2010

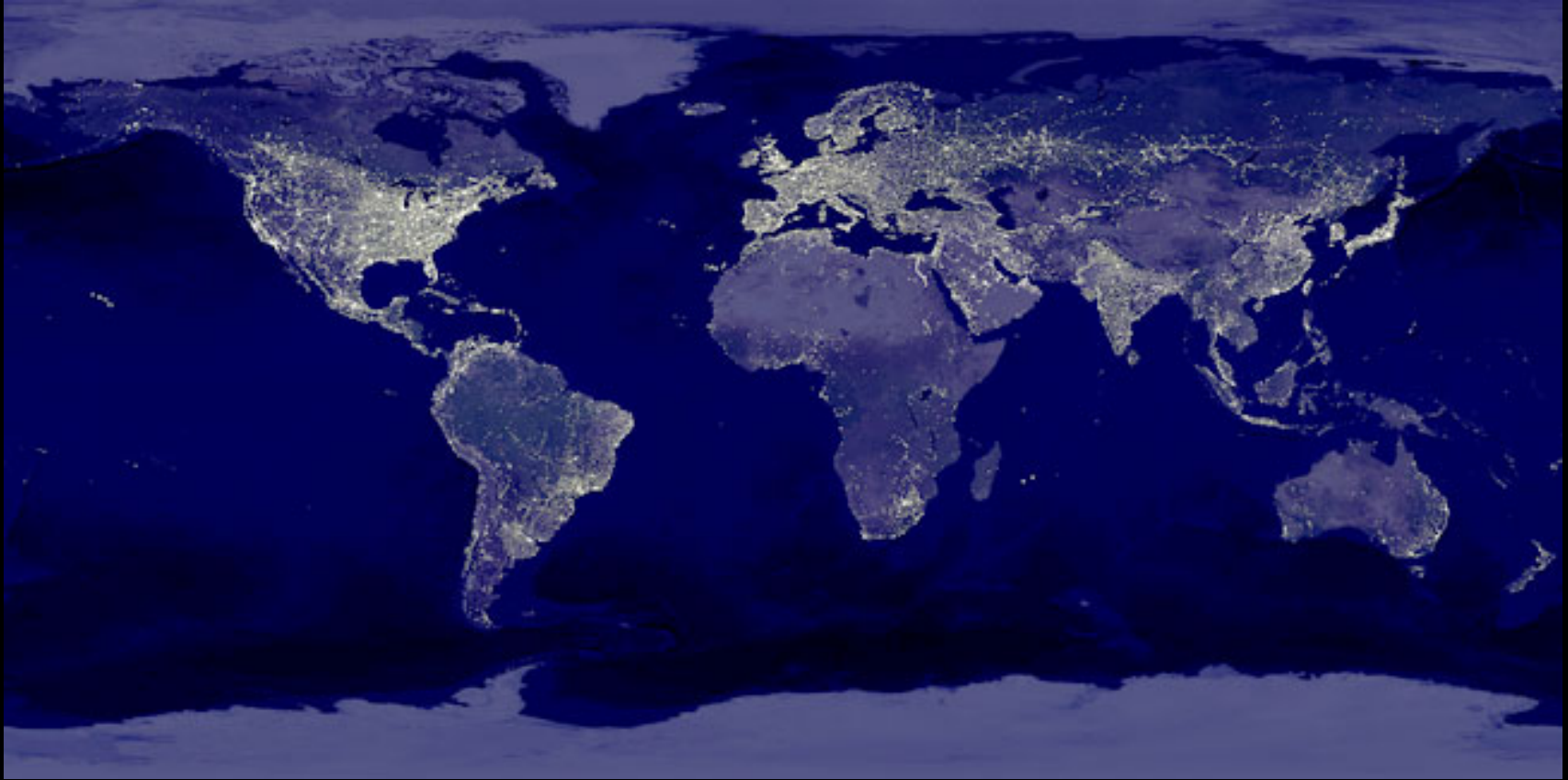
...when conventional wisdom makes no sense



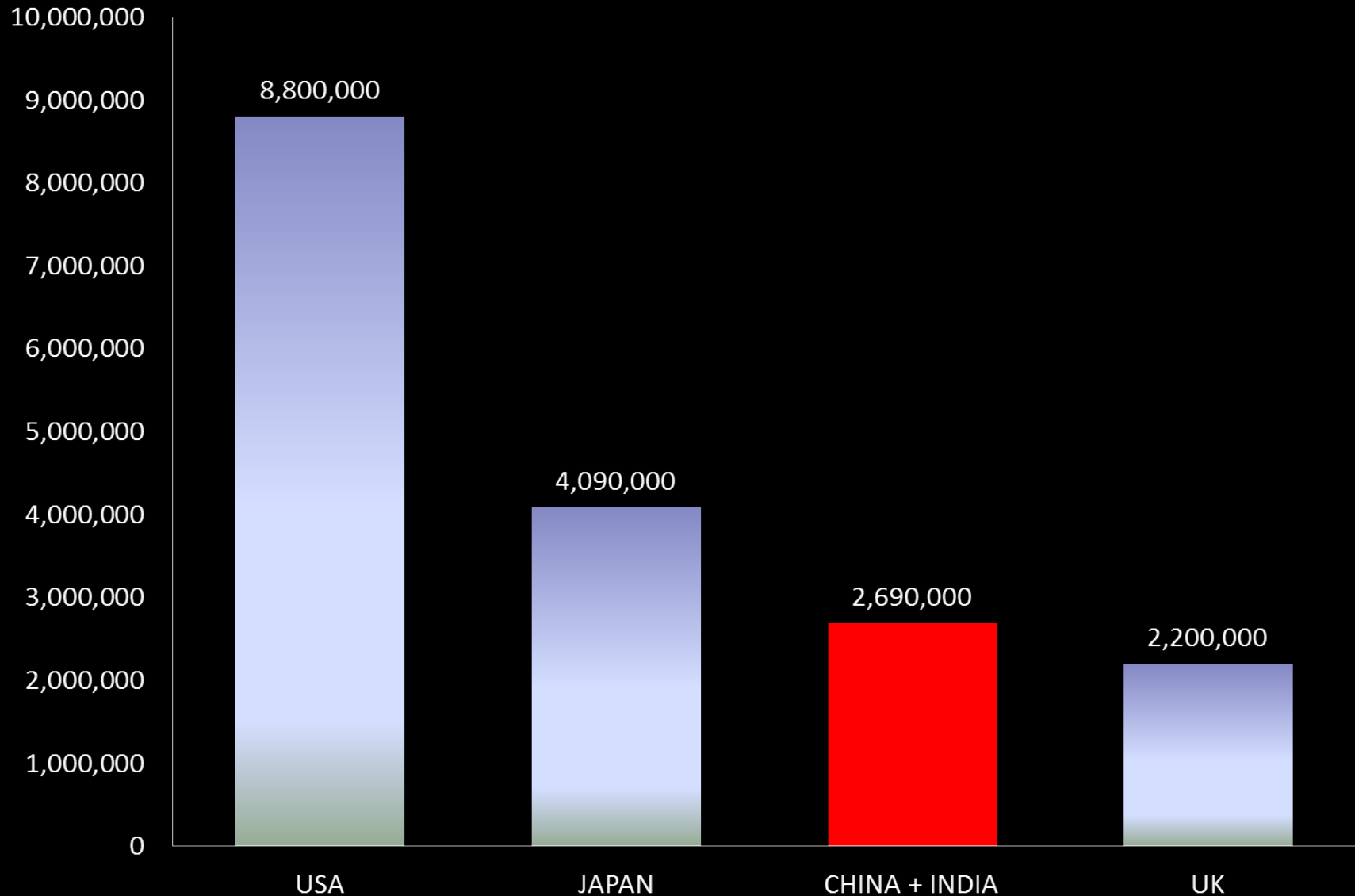
in a 2005 study of 80 critically ill patients, “there were seven deaths in people getting standard treatment and only one in those allowed to have fever...”

...at which point the study was halted due to ethical concerns

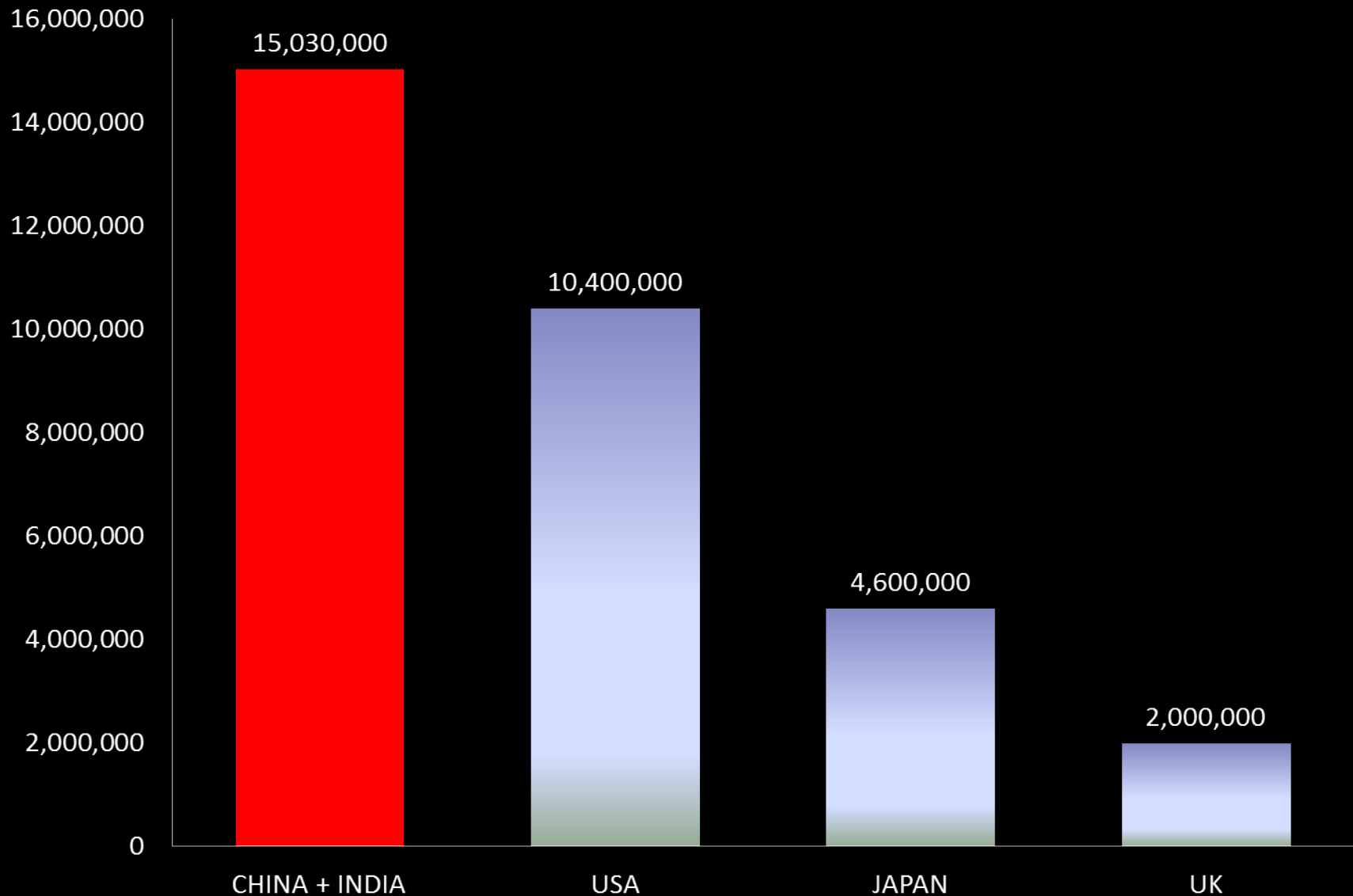
**...when 5B people live like 500M do today**



# ...worldwide car sales: 2000

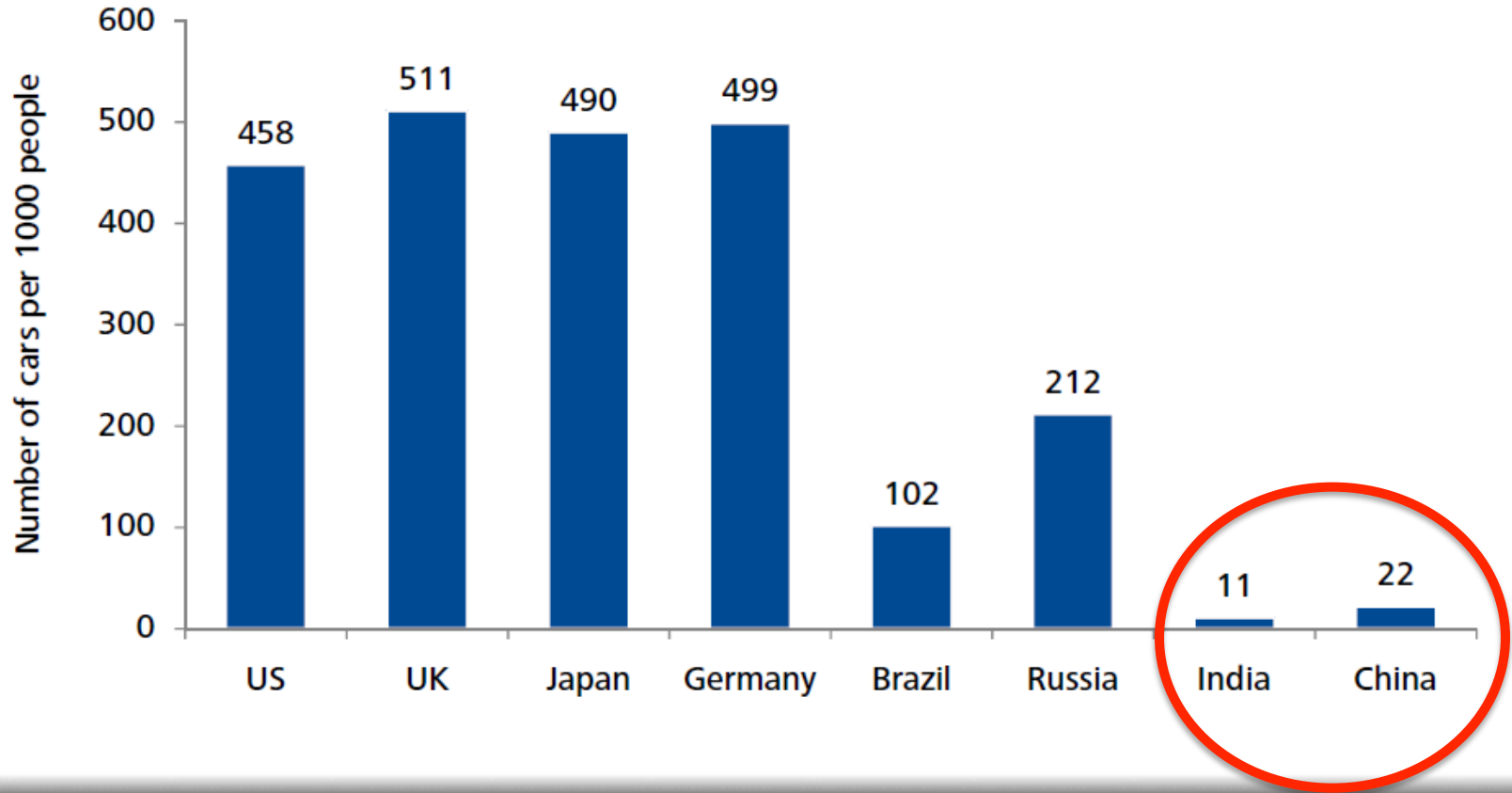


# ...worldwide car sales: 2009



# ...but still plenty of room to grow!

Number of cars per 1000 people (2008)



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# ...the chindia test

only scalable if competitive unsubsidized

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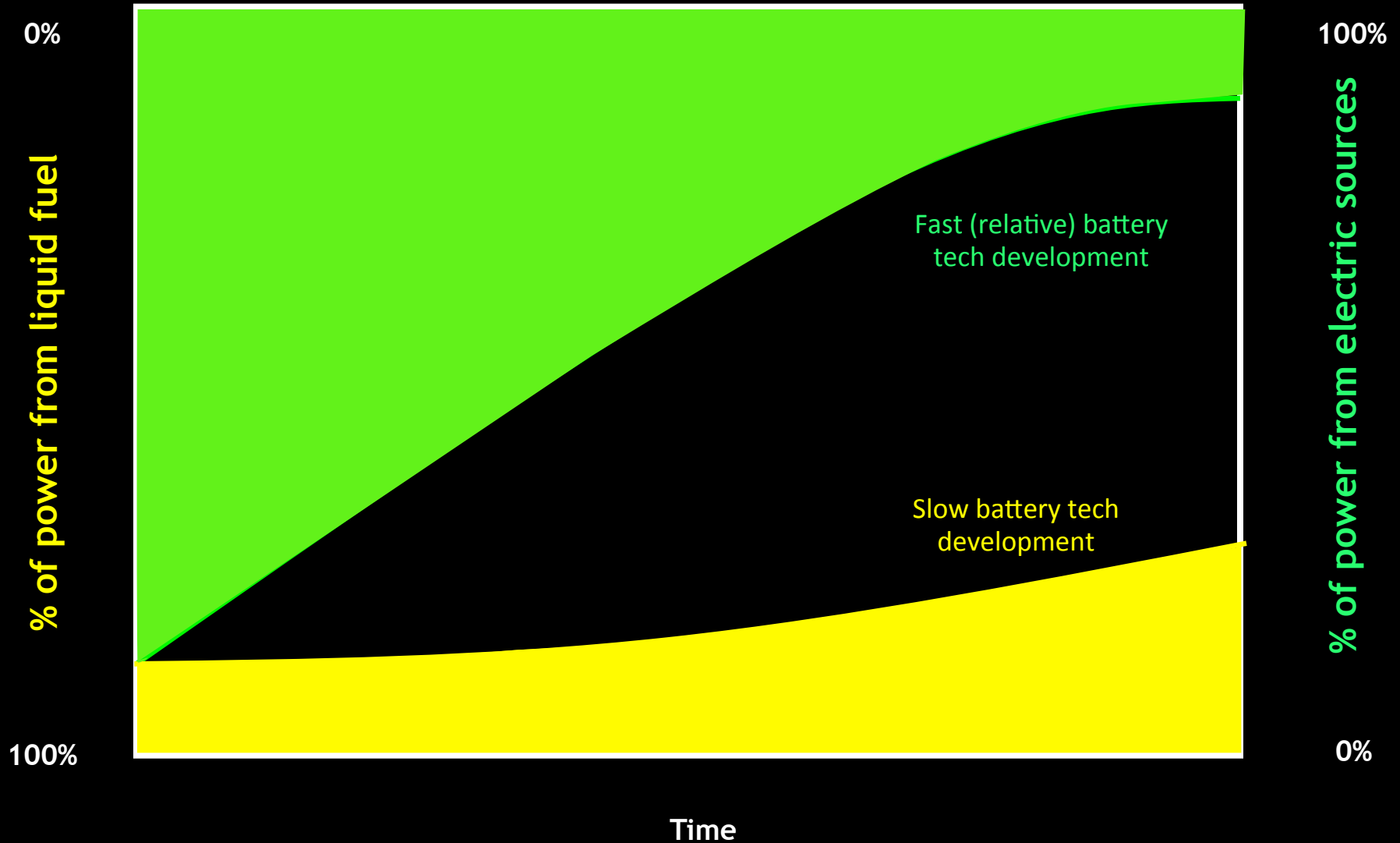
# Volt or Nano?



Tata Nano: 203,000 pre-orders  
or  
Chevy Volt: 45,000 by 2012



# ... liquid fuel vs. battery



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...traditional views?

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# ...green: batteries vs. ICE



...electric cars aren't an easy "fix-it"





# ... coal in China



# ... the BP oil spill



... coal mining





... the sources of petroleum



# ...What are the real issues?



Cost of aircraft carriers in Persian Gulf (1976 - 2007): \$7.3 TRILLION!

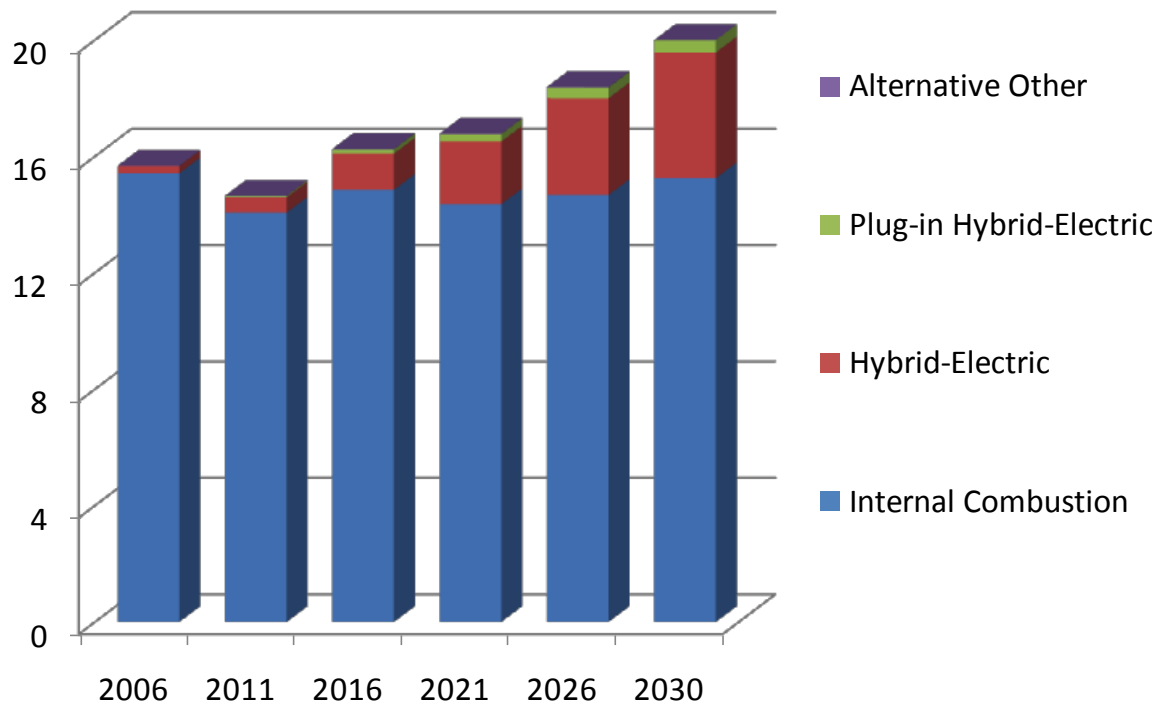
# ...electric does not solve anything by itself



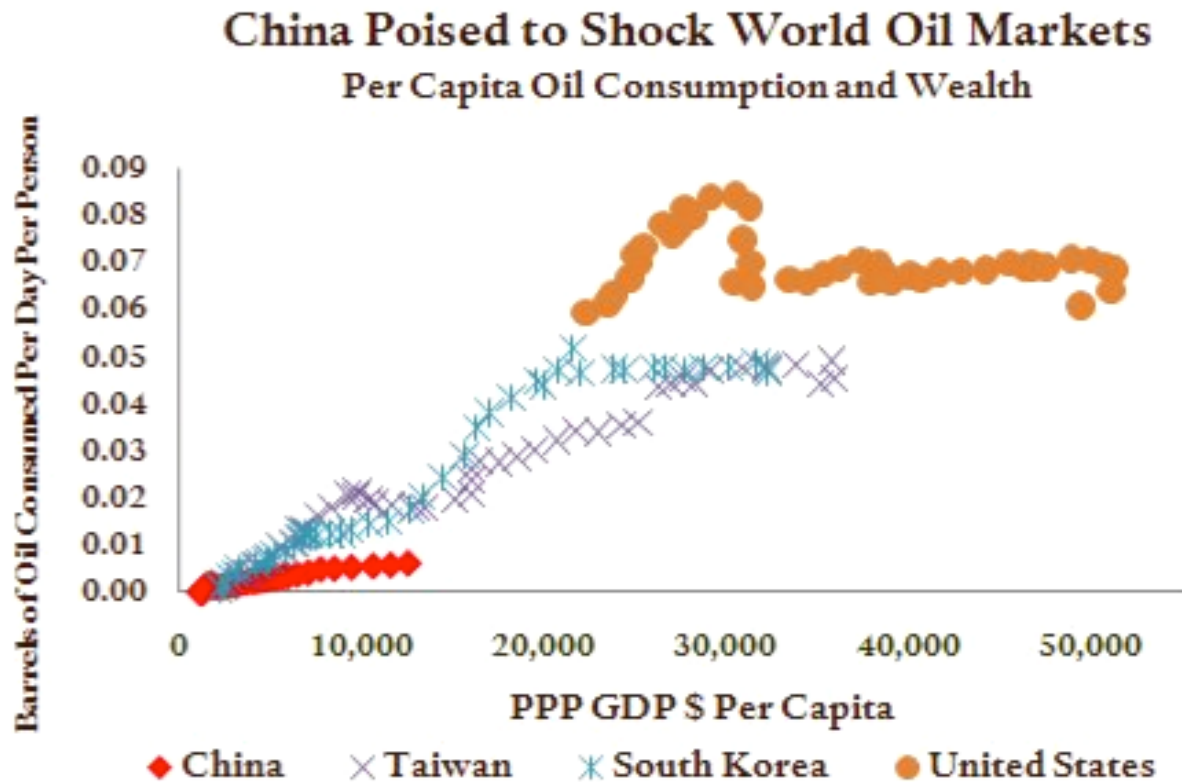
“China's dirty and dangerous coal mining industry cost the country a hidden \$250 billion last year in lost and damaged lives, wasted energy and environmental devastation.”

# Impact on CO2 & oil use : ICE or EV?

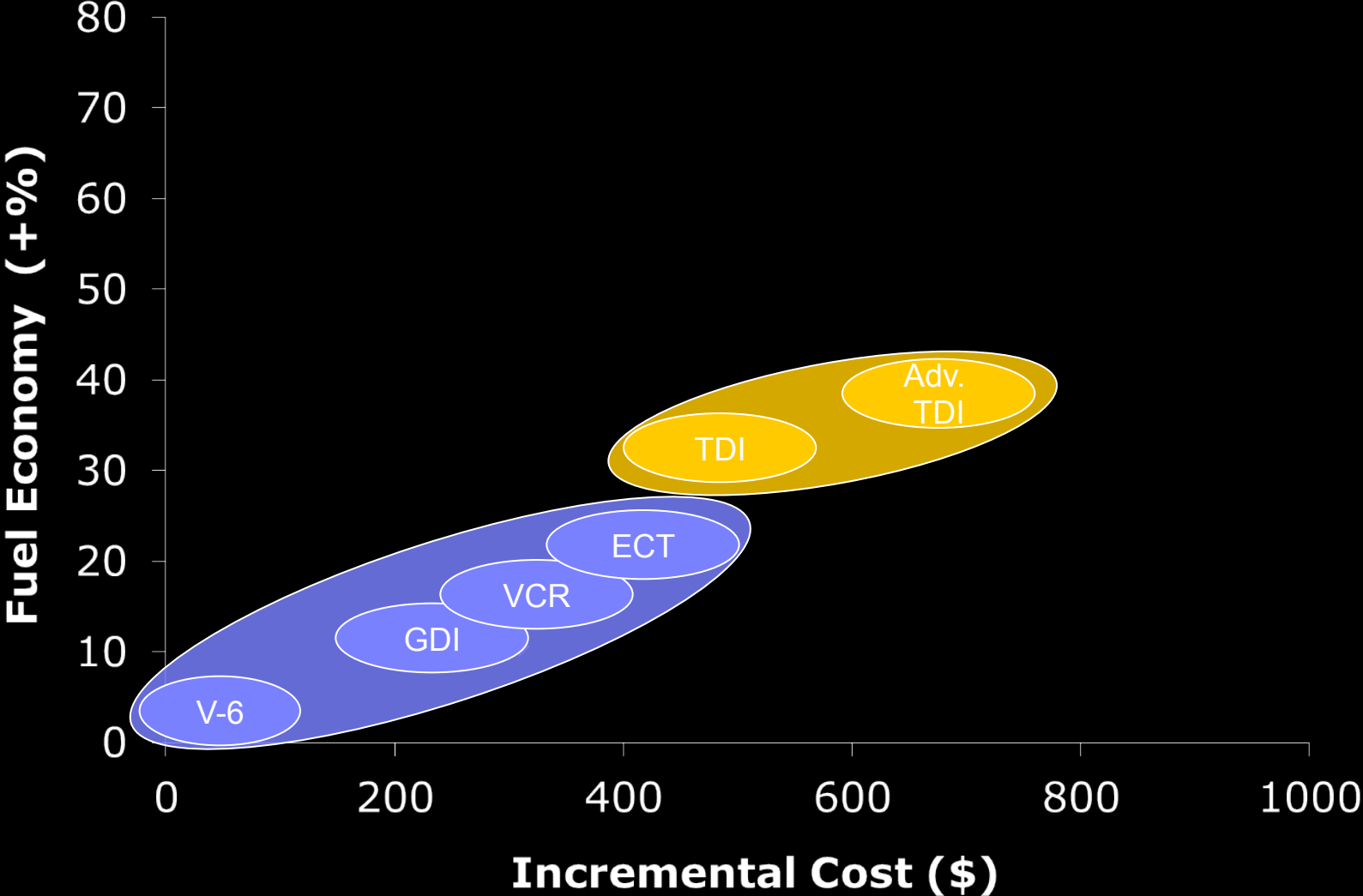
U.S. New Vehicle Sales by Technology (millions)



If China's per capita oil use = South Korea, its share of global use goes from 10% to 70%!

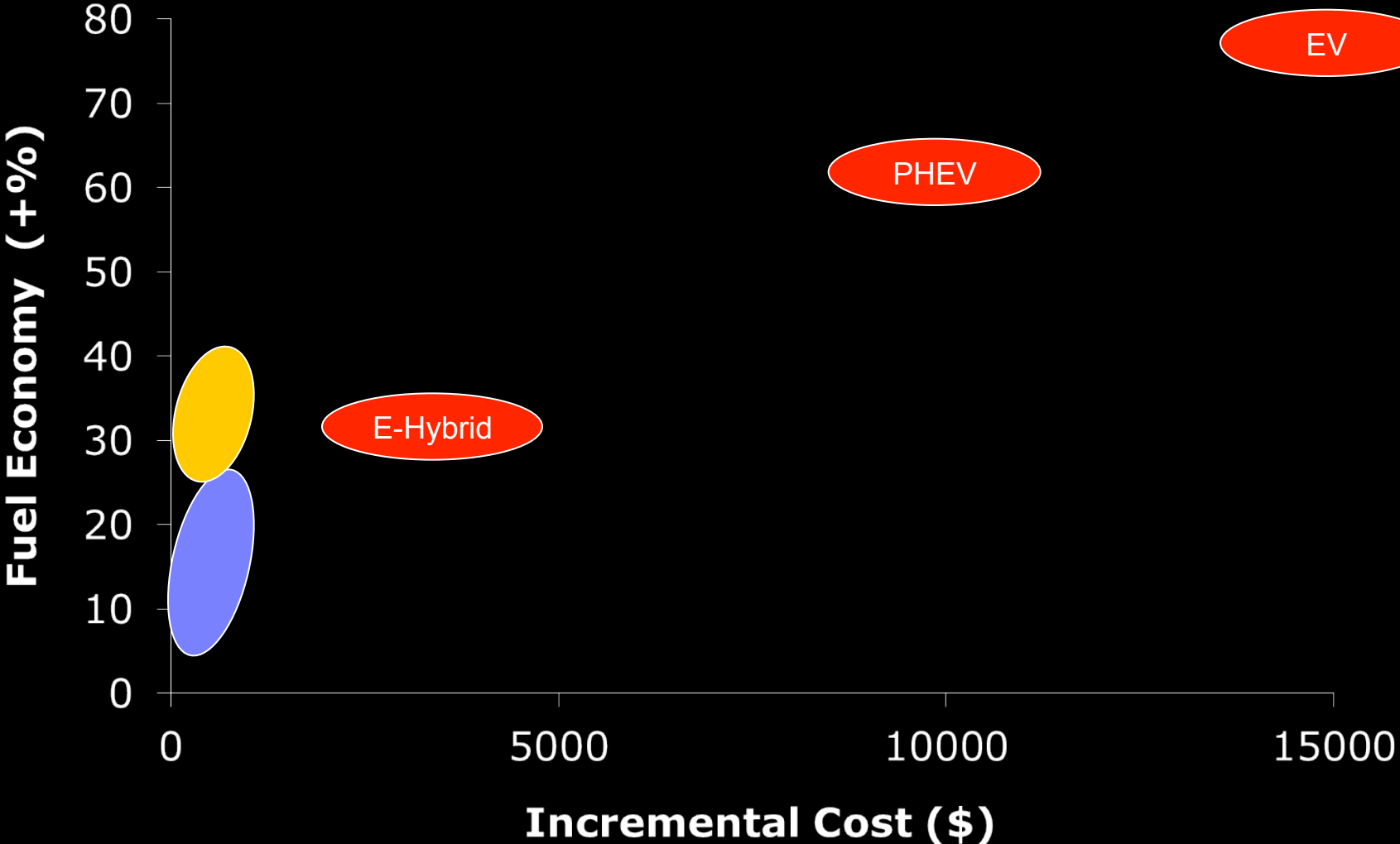


# Technology Choices



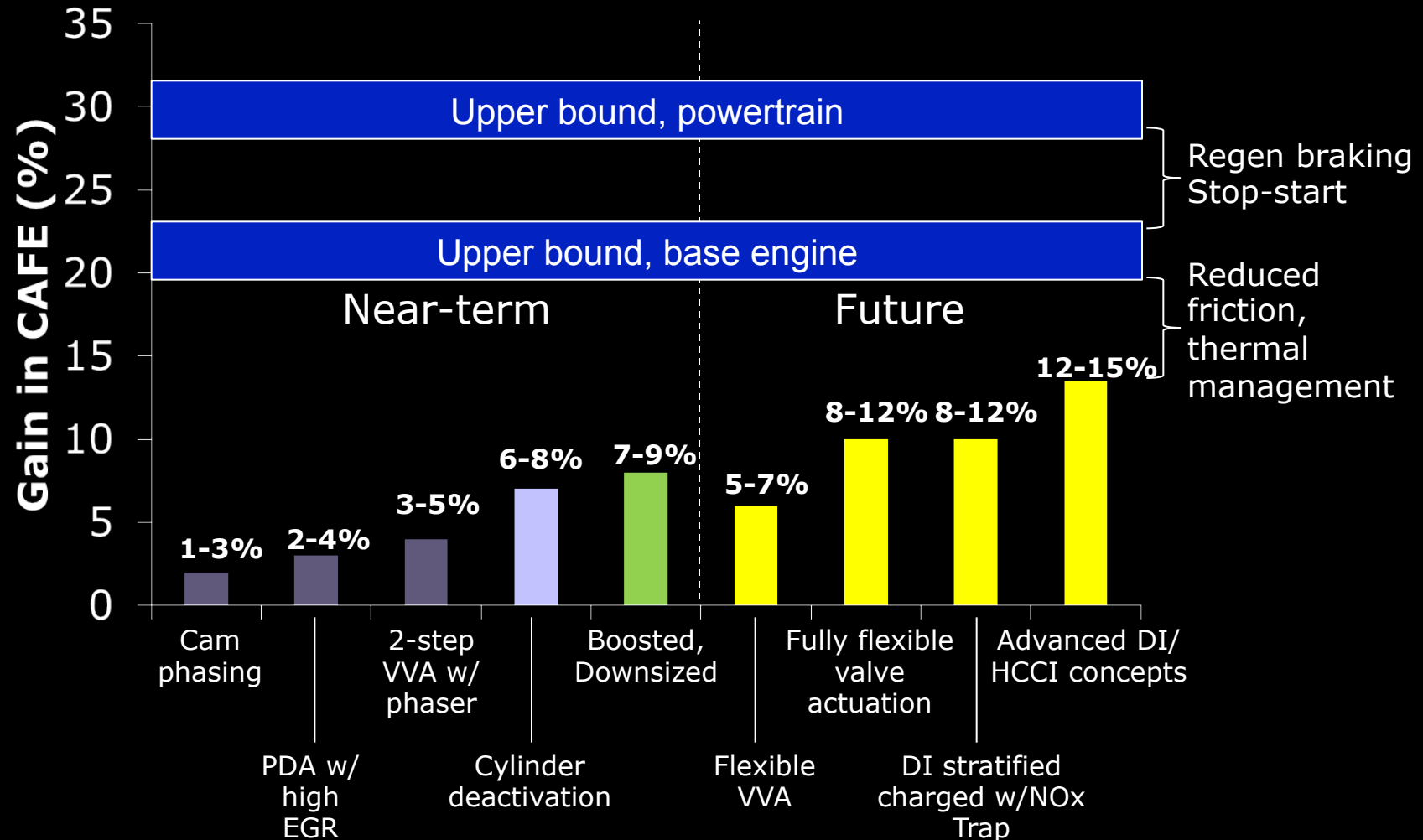
Source: Estimates from discussions and the working committee of Academy of Science

# Technology Choices



Source: Estimates from discussions and the working committee of Academy of Science

# incremental gains continue over time





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...unconventional

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“The fine line separating the delusional from the visionaries amongst us is often not foresight, but rather hindsight.”

Ben Semel

# ...our approach: crazy risks

Projects/plans or “shots on goal”

Safe or Likely to fail

Fiduciary investing or Non-fiduciary

Ready...

Fire!

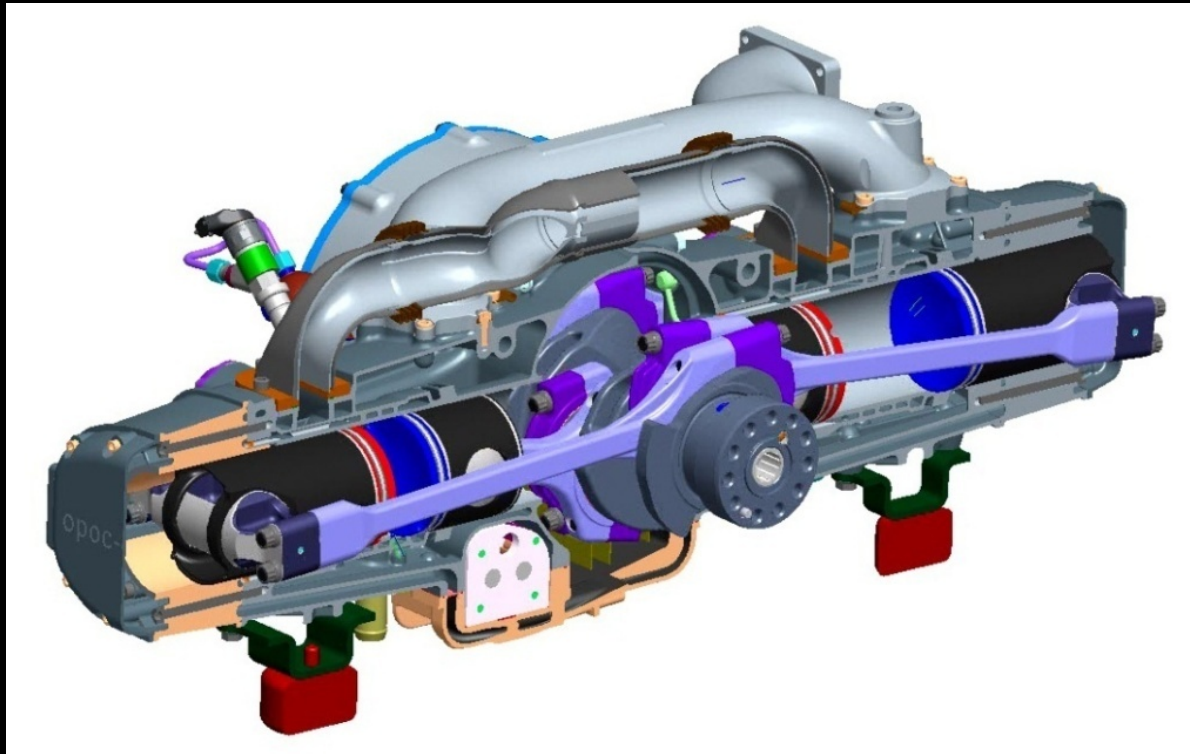
...Aim

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# Ecomotors

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# ...the Ecomotors story



re-examination of a 100 year old idea ...

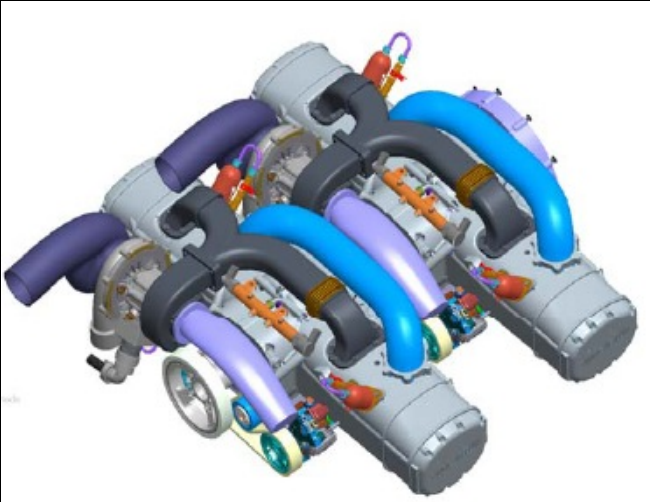
...an entrepreneur with a track record of defying the naysayers

# ...everyone told me:

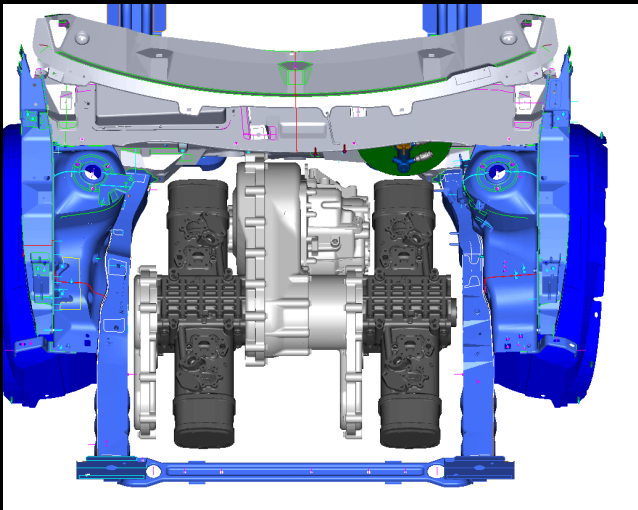
1. It is not possible to convert a gasoline engine to a Diesel, using the same transfer line. I did it and it is the most successful Diesel in the world and it was copied by everybody.
2. The combustion for a high speed Diesel is not possible. I started production with a 5000 rpm Diesel with 2000 engines/day on the gasoline engine transfer line.
3. You cannot use a rubber toothed belt to drive the camshaft and the injection pump. I did it and it is the standard solution today.
4. It is not possible to use an aluminum radiator because the corrosion will destroy the engine. I did it and it is the standard solution today.
5. It is not possible to create an “emission free” natural gas burner. I did it. It is in mass production at VIESSMANN. BUDERUS sued VIESSMANN about “emission free” and lost.

# ....OPOC Engine

Dual Module Design



Unique Tribrid Design



## OPOC Fuel Efficiency (+50-60%)

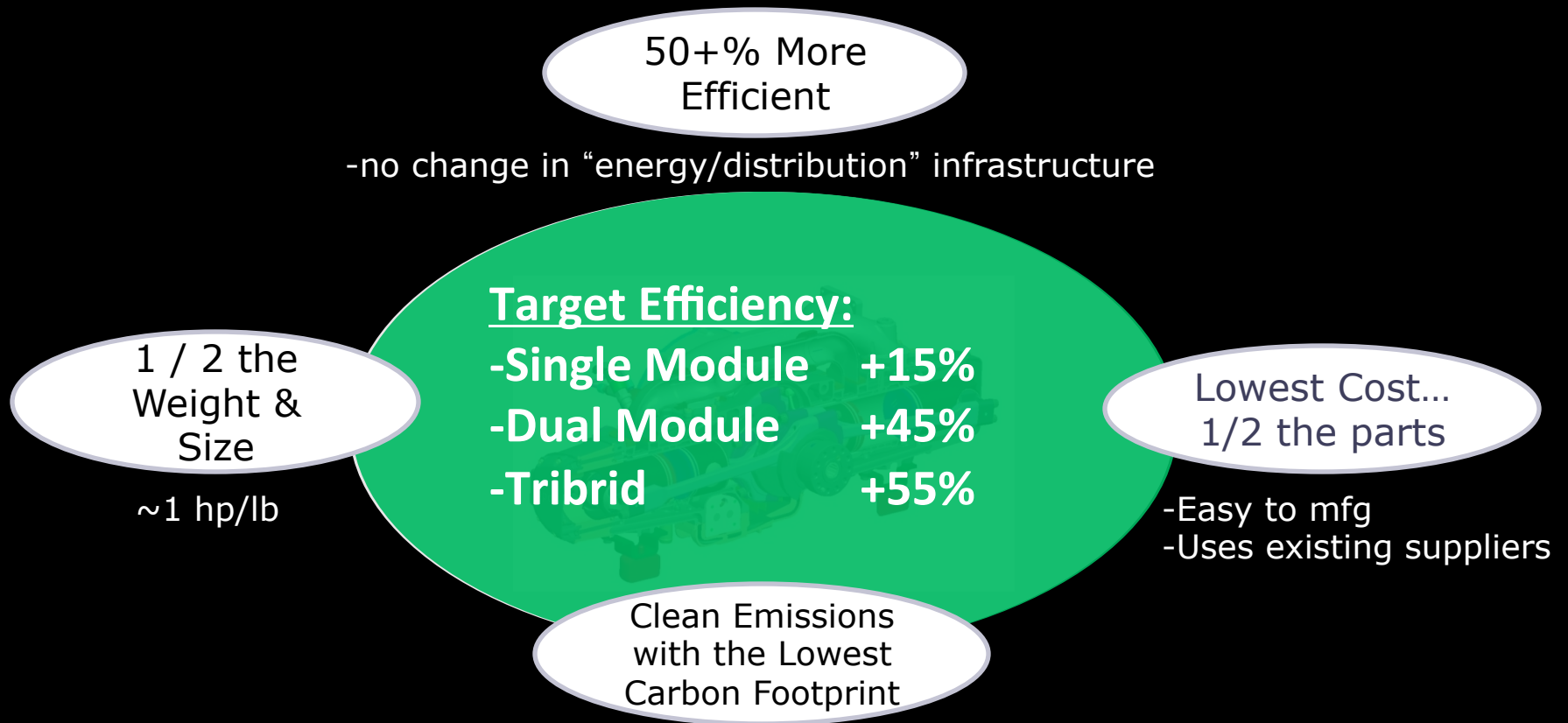
- Single Module: +15%
- Dual Module: +30%
- Tribrid: +10%
- Application Opportunity: +5%

## Fully Balanced Module

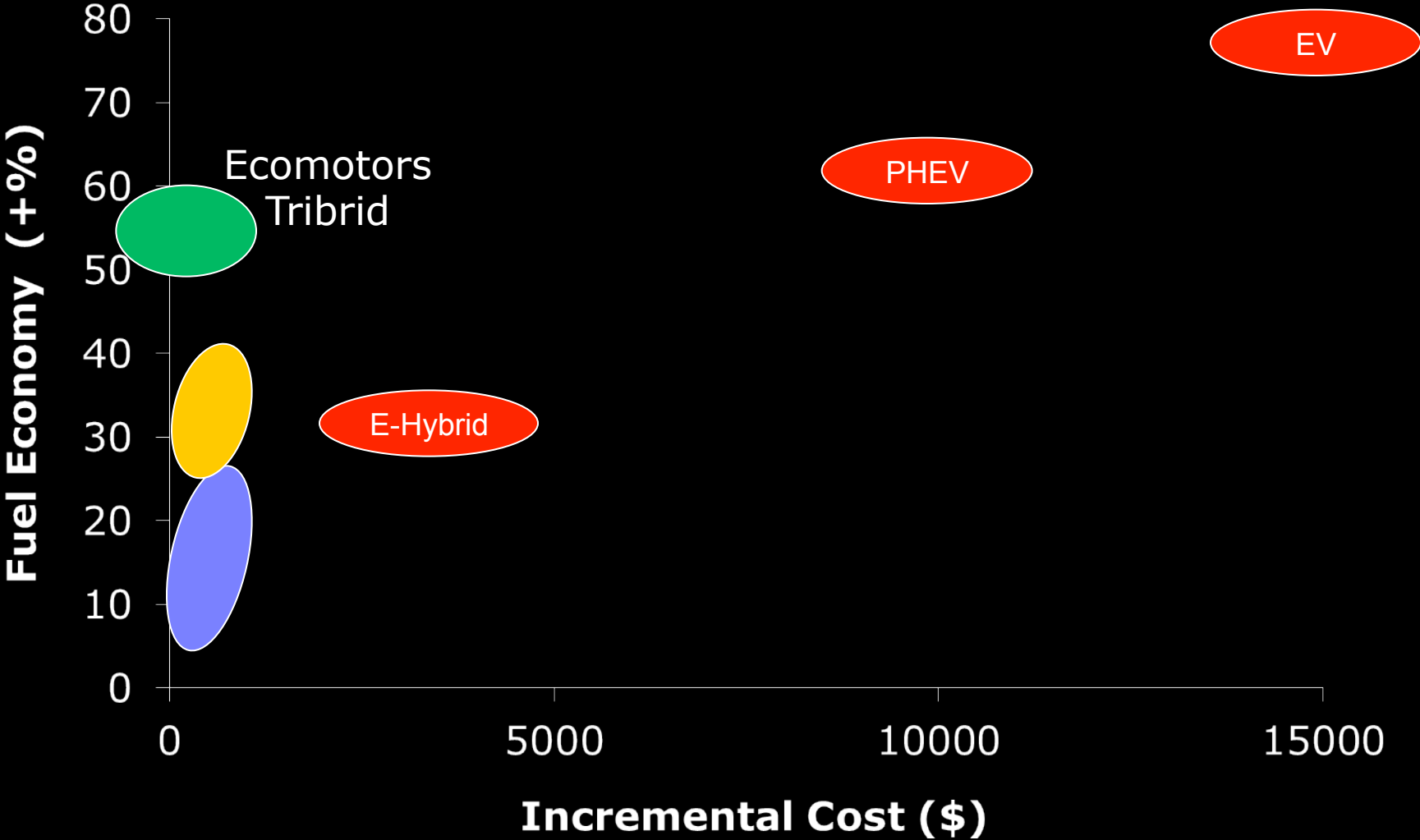
- Enables Stackable Power Modules
- Enables Hybridization and Tribrids
- Enables module shut off



# EcoMotors' Technology Targets

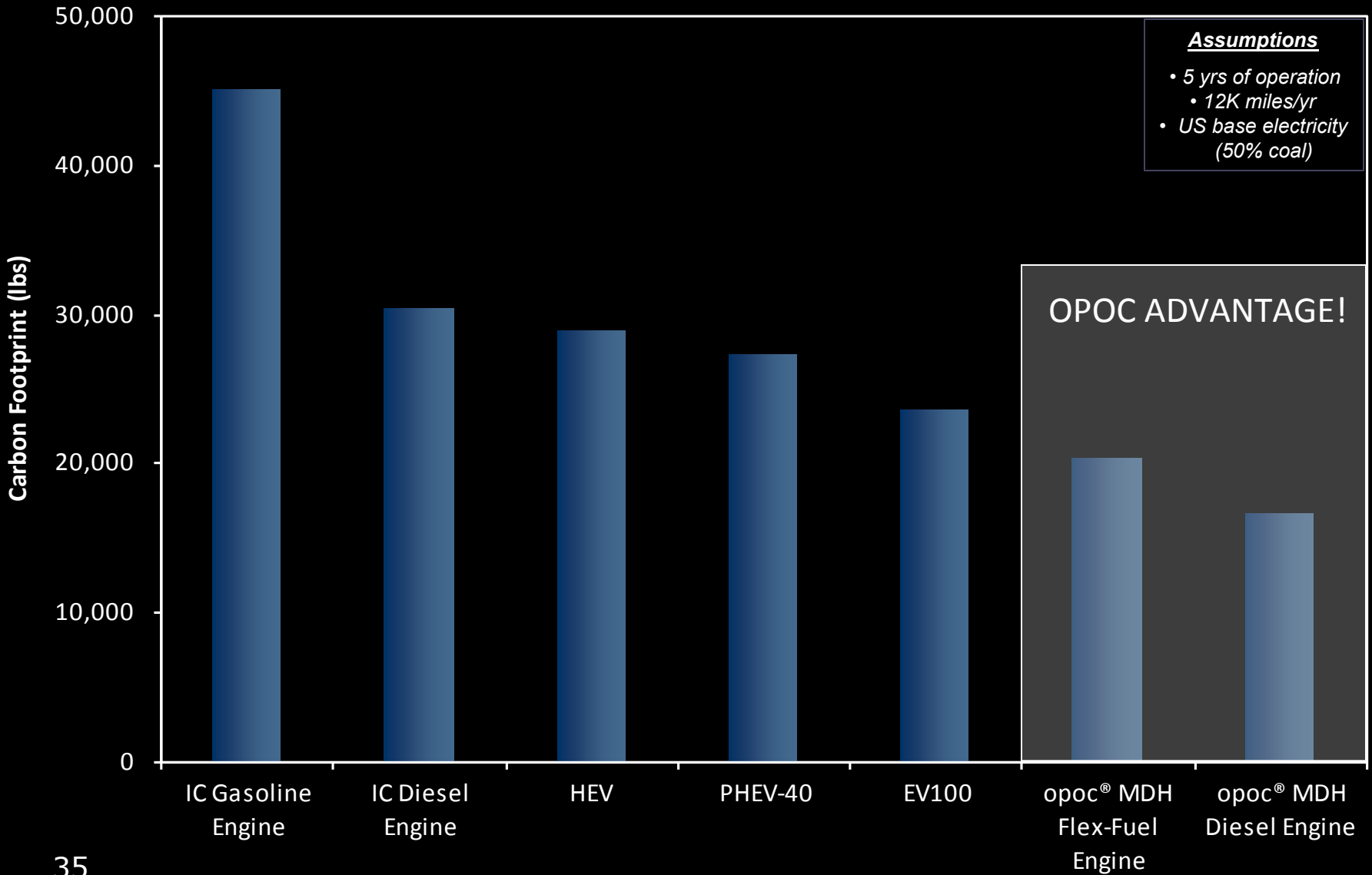


# Technology Choices

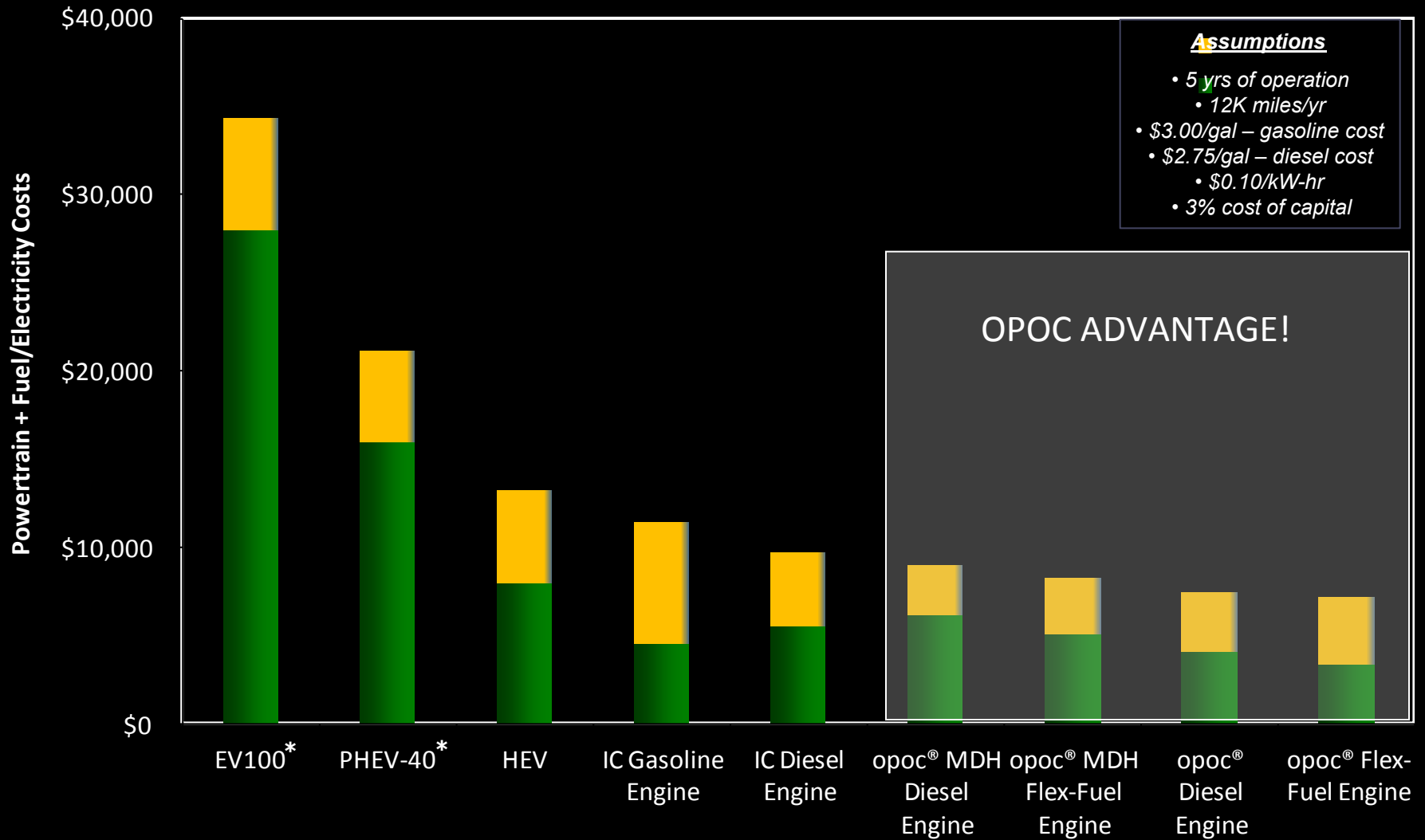


Source: Estimates from discussions and the working committee of Academy of Science

# Smallest Carbon Footprint



# Lowest Cost...Initial Cost & Operating Cost



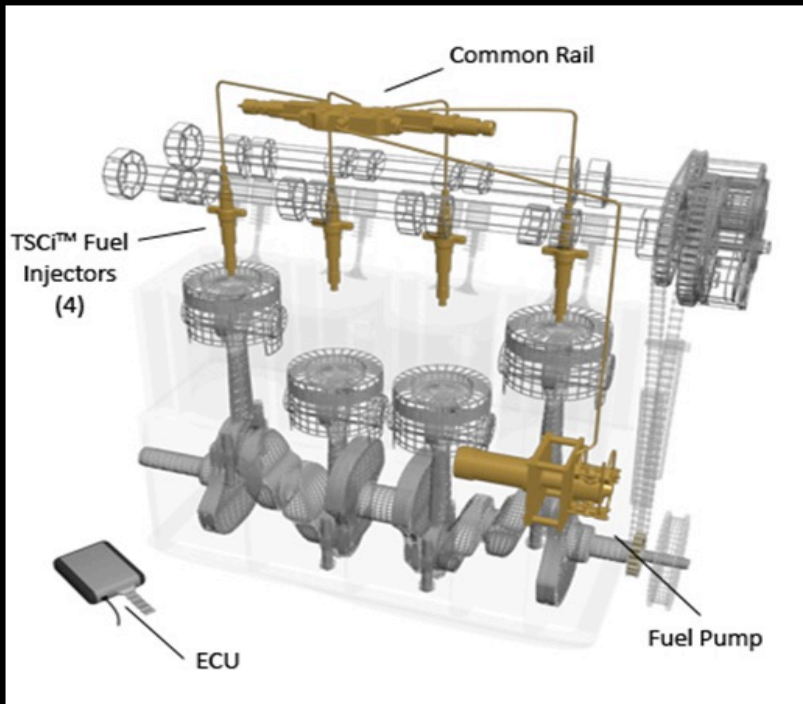
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# Transonic

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# ...the Transonic idea

## SUPERCRITICAL FUEL INJECTION



## TSCi™ FUEL INJECTION



**Supercritical Injection**

**400°C**

**Catalyzed**

**Low Octane Gasoline**

**Optimized Combustion**

## GASOLINE DIRECT INJECTION (GDI)



**Liquid Injection**

**100°C (uncontrolled)**

**Non-Catalyzed**

**High Octane Gasoline**

**Combustion before TDC**

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# NRG Dynamix

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# NanoStellar

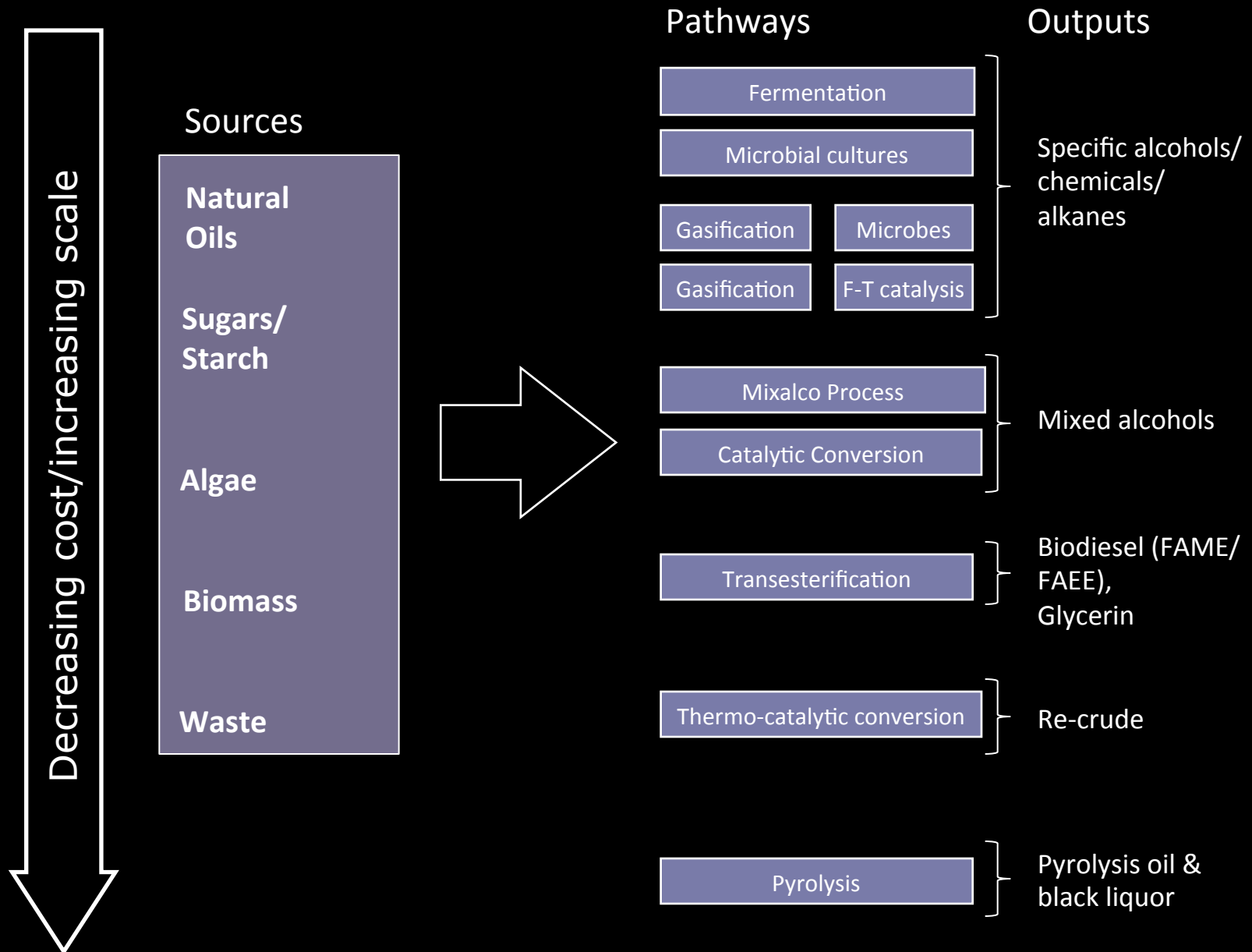
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# Fuels

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# ...fresh approach to fuels



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# Amyris

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# Gevo

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# Coskata

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# Kior

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# Batteries

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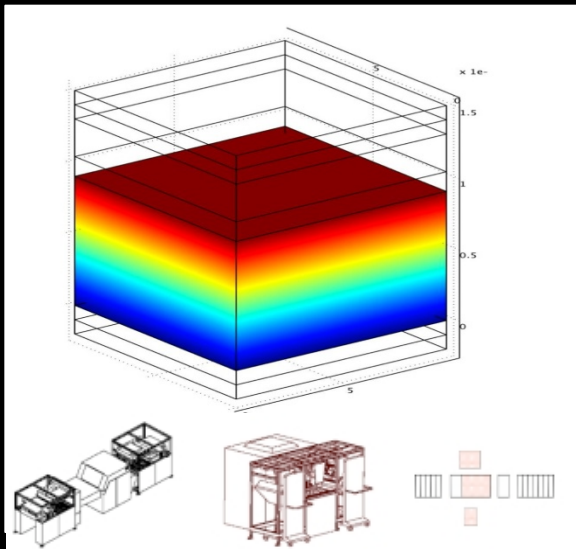
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# Sakti3

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# Advanced modeling drives Li-ion leaps

## Computation



- Finite element
- Multi-physics
- Surrogate-based analysis

## Manufacturing



- Reduced experimentation
- High throughput
- Low cost

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**Seeo**

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# Pellion

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# ReCapping

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# ...batteries

Next Generation Li-ion?

Different ions?

Quantum thingamajig?

**And the weirdest ones we have not heard about...**

**...unlikely but not unimportant**

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...redefine the future

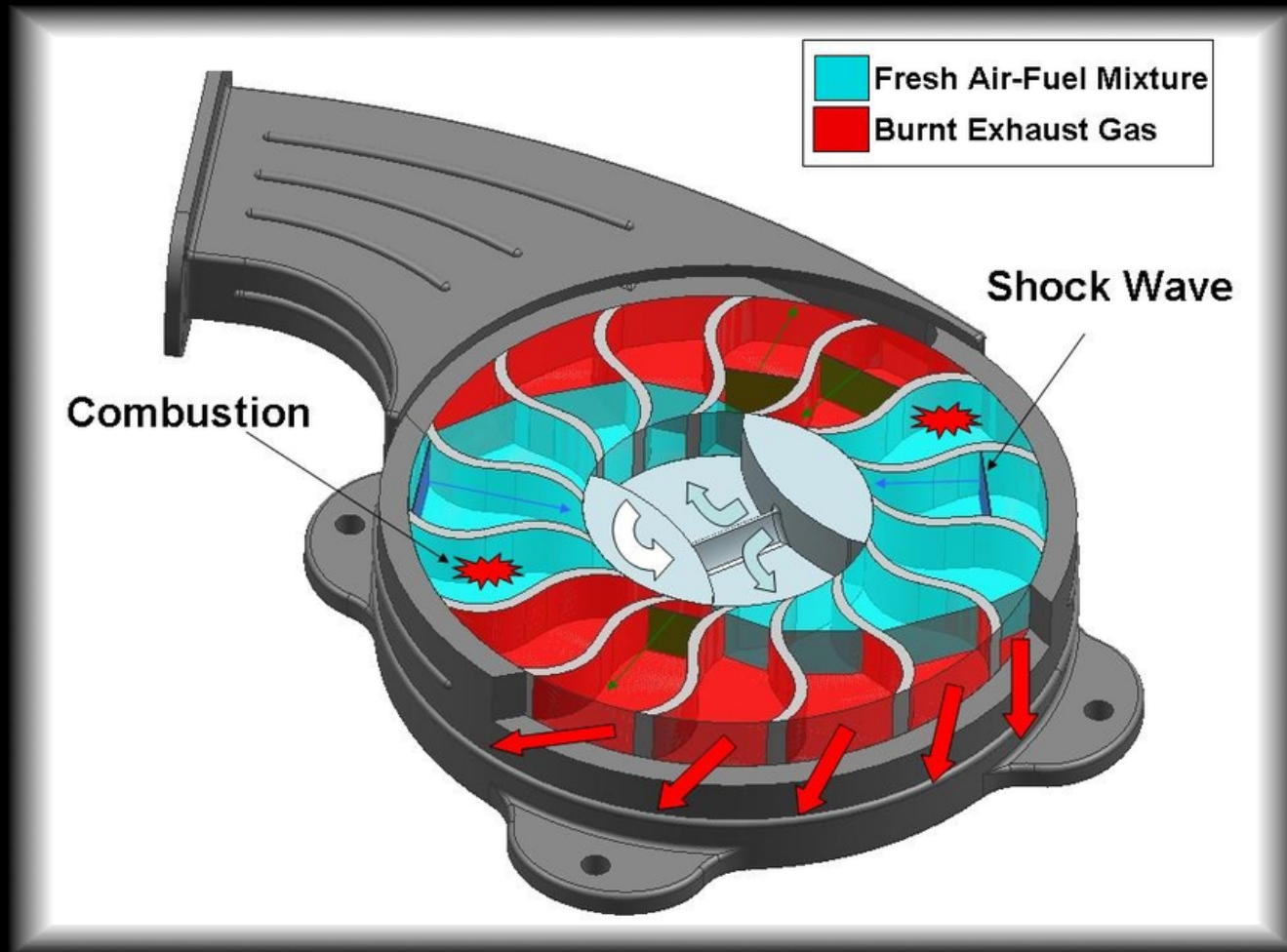
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# breakthrough ideas

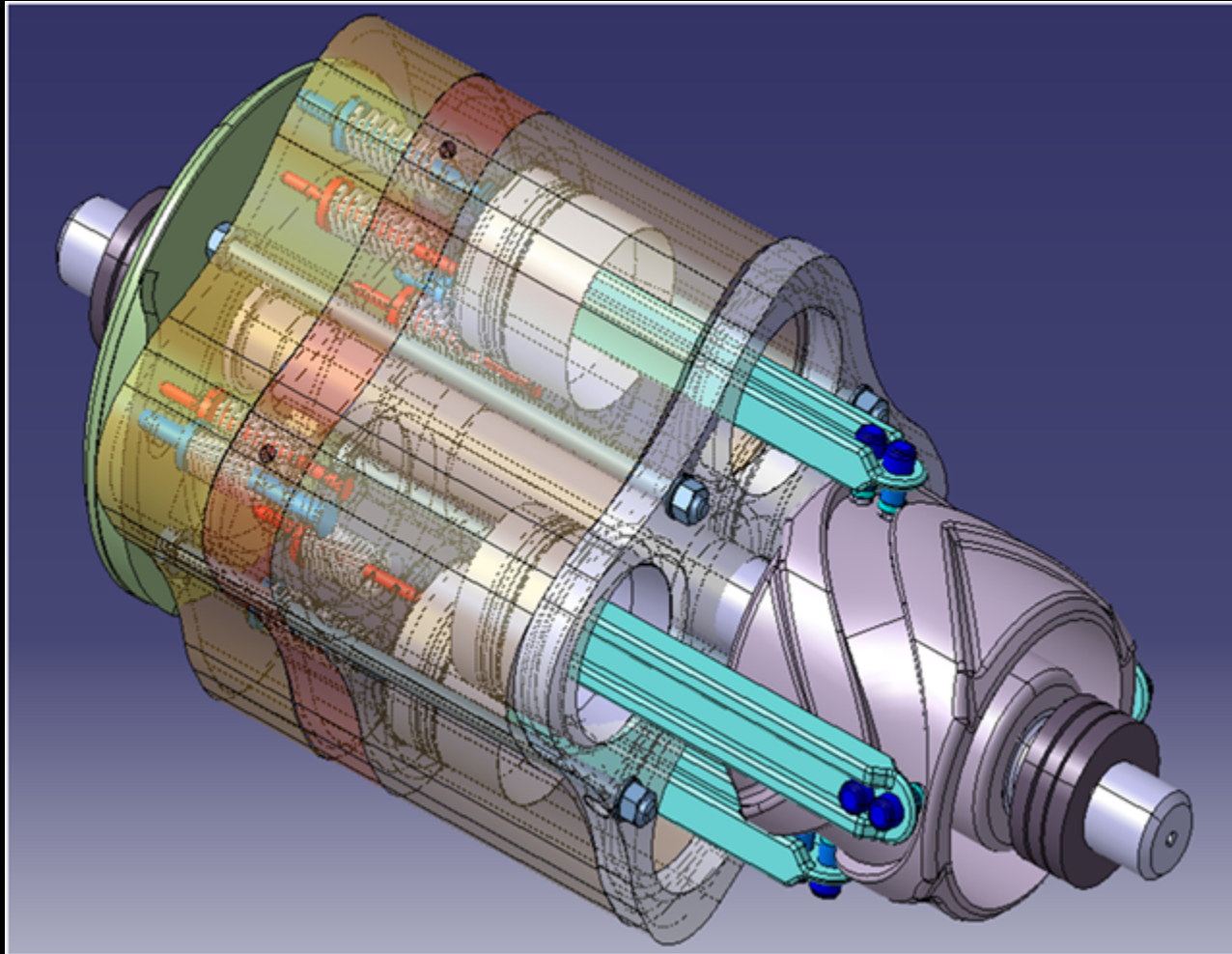
- 1) Hydraulic and hydro-static hybrid drives
- 2) Low cost high efficiency engines (OPOC)
- 3) Ultra-high compression engines
- 4) Advanced injectors for improved combustion (TSCI)
- 5) Very cheap energy storage
- 6) Massive weight reduction (nanosteel, carbon fiber)
- 7) Digital fuel processing
- 8)
- 9) ....today' s unimaginable!

# ...the wave-disc engine?

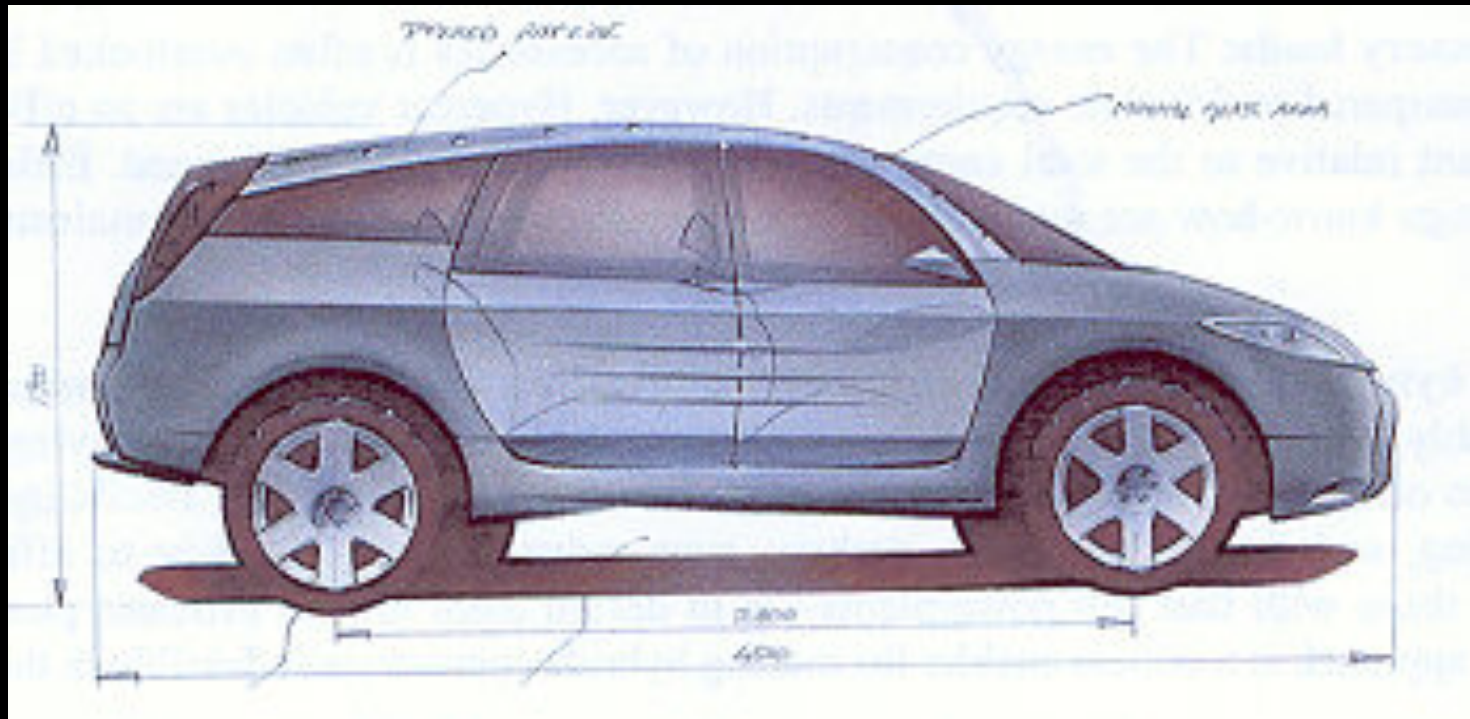


5X efficiency in electricity production, 20% lighter, and 30% cheaper?

# ...the crankless engine?



# ...the hypercar?

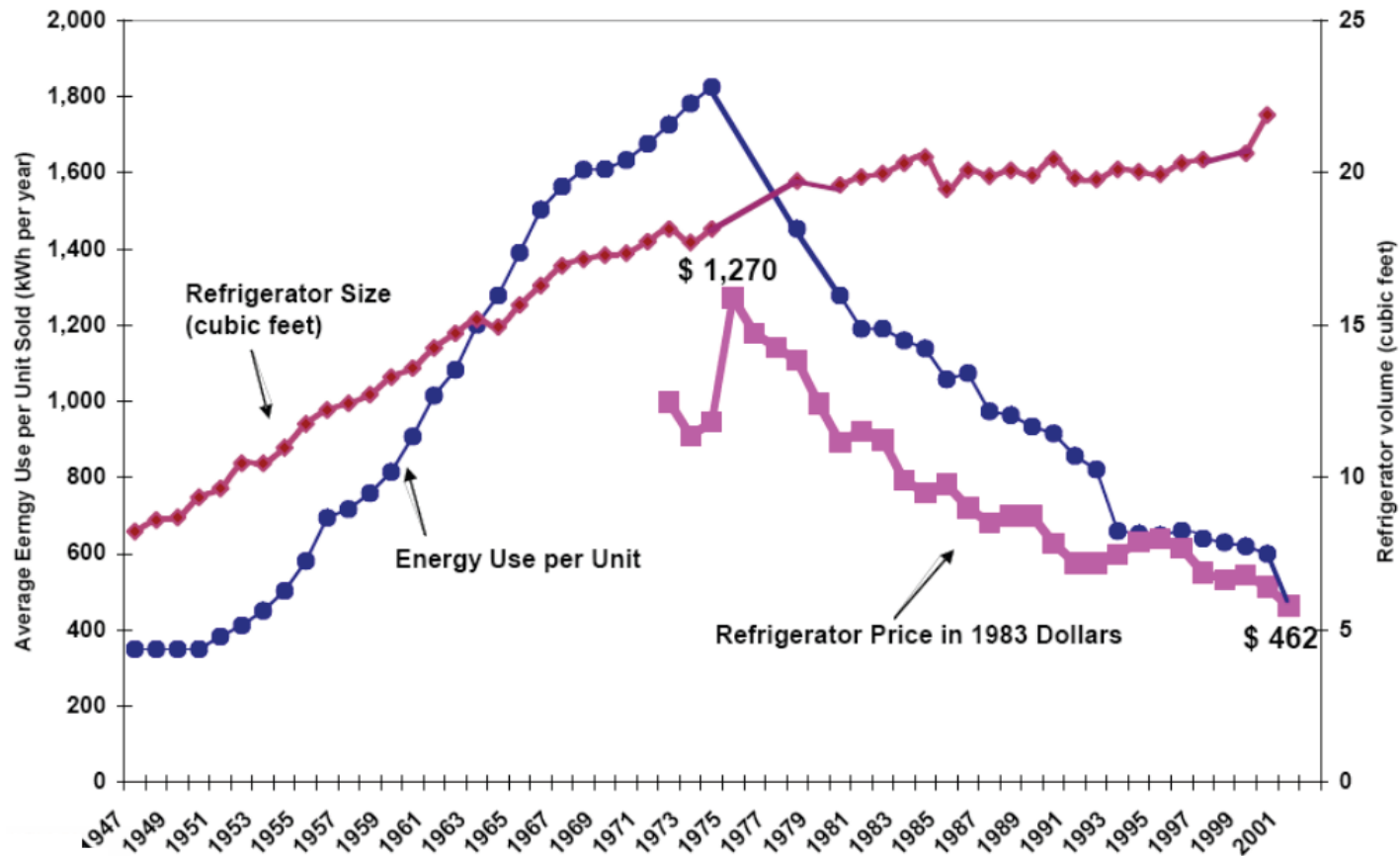


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...imagine the possible

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# ... the “Rosenfeld” effect

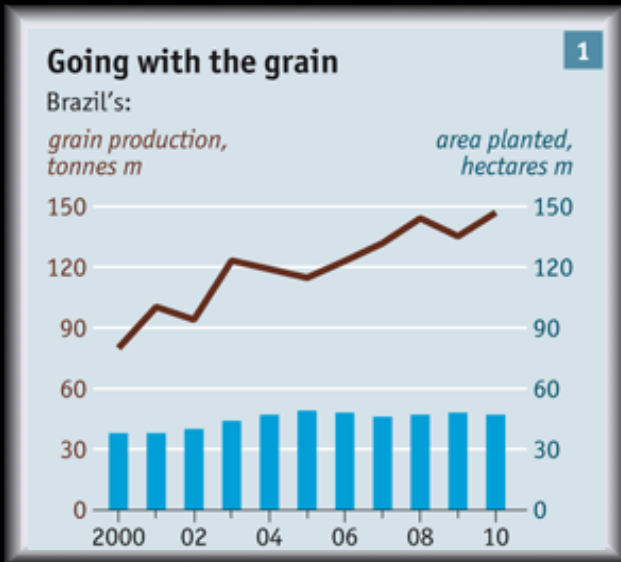


refrigerator costs AND energy use continued to decline!

# ...Brazilian Cerrado – evolution of a bread basket



the father of the Green Revolution thought these soils were never going to be productive. They seemed too acidic and **too poor in nutrients...**



**...More arable land has been *created* in Brazil than is under cultivation in the US and India combined**



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...knowing too much

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# the folly of experts: tetlock study

**hundred's of experts.**

**80,000+ “expert” forecasts & 20+ years**

**Results: Experts are about as good forecasters as  
dart-throwing monkeys**

# even more?

**...using data from a test  
used to diagnose brain  
damage**

**... The clinical psychologists'  
diagnoses were no better  
than the secretaries**

# ...the sources of innovation

- Google, Facebook, Twitter : Fox, NBC, CBS
- Amazon : Walmart
- First Solar : Shell & BP Solar
- Cree : GE
- DNA Sequencing

# redefining swans



# “black swan”

...rarity, extreme  
impact, and  
retrospective  
(though not  
prospective)  
predictability

# takeaways

- Bang for the Buck prevails
- Economic gravity always wins
- Unconventional thinking drives disruptive change
- Technology not politics drive long-term trends
- Black Swans are likely
- Imagine the possible, don't focus on the probable
- Invent the future

# ...let's avoid silliness

EPA DOT | Fuel Economy and Environmental Comparison



The above grade reflects fuel economy and greenhouse gases. Grading system ranges from A+ to D.

Smartphone 

[website.here](#)

Over five years, this vehicle **saves \$6,900** in fuel costs compared to the average vehicle.

**Electric Vehicle**

Range (miles)	kWh/100 Miles	MPGe City	MPGe Highway	CO <sub>2</sub> g/mile (tailpipe only)	Annual fuel cost
99	34	102	94	0	\$618




Combined MPGe: 98 | CO<sub>2</sub> g/mile: 0 | Other Air Pollutants: 0

- Fuel economy for all midsize cars ranges from 12 to 103 MPGequivalent.
- MPGequivalent: 33.7 kWh=1 gallon gasoline energy.
- Annual fuel cost based on 15,000 miles per year at 12 cents per kWh.


Visit [website.here](#) to calculate estimates personalized for your driving, and to download the Fuel Economy Guide (also available at dealers).



EPA DOT | Fuel Economy and Environmental Comparison



The above grade reflects fuel economy and greenhouse gases. Grading system ranges from A+ to D.


Smartphone 

[website.here](#)

Over five years, this vehicle **saves \$1,600** in fuel costs compared to the average vehicle.

**Dual Fuel (Gas & E85) Vehicle**

Gallons/100 Miles	Gasoline MPG City	Gasoline MPG Highway	CO <sub>2</sub> g/mile (tailpipe only)	Annual fuel cost
4.0	22	30	355	\$1,680



Combined MPGe: 25 | CO<sub>2</sub> g/mile: 355 | Other Air Pollutants: 7

- Fuel economy for all midsize cars ranges from 12 to 103 MPGequivalent.
- Ratings are based on gasoline and do not reflect performance and ratings using E-85.
- Annual fuel cost based on 15,000 miles per year at \$2.80 per gallon.
- See the Fuel Economy Guide for more information.

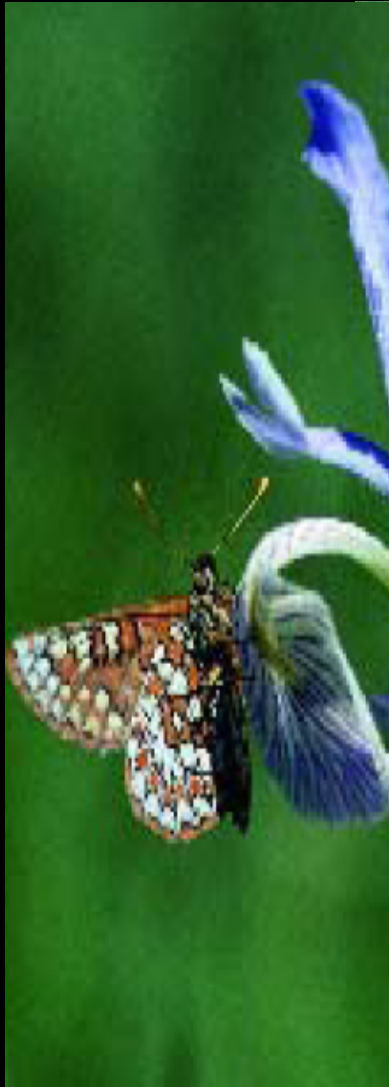
Visit [website.here](#) to calculate estimates personalized for your driving, and to download the Fuel Economy Guide (also available at dealers).



# ...and focus on the issues



# Safe or Not?



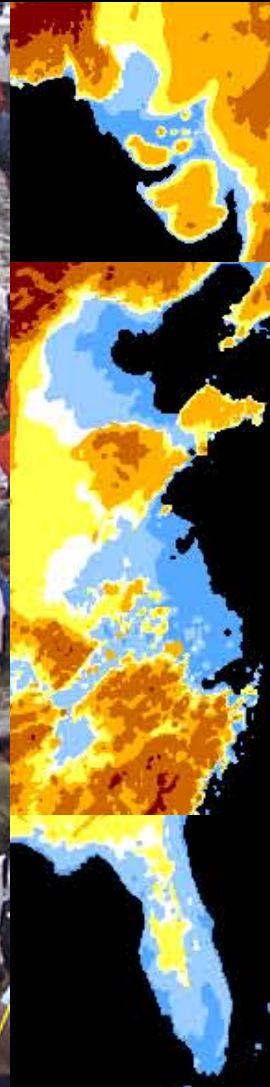
**Extinctions  
System Losses**



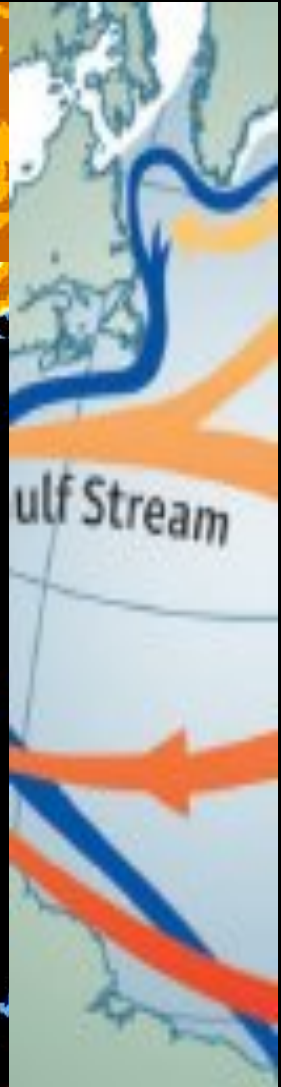
**Hurricanes  
Fires, Floods**



**Flooding  
NY Flooded**

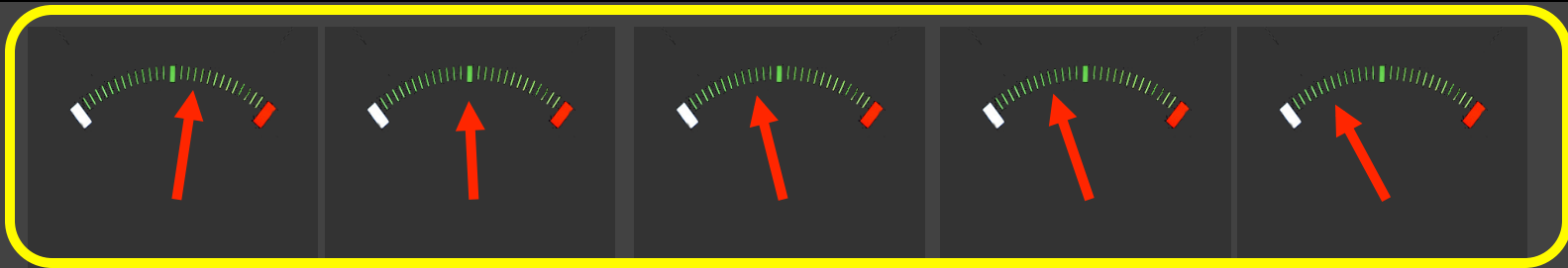


**600 M  
Displaced**

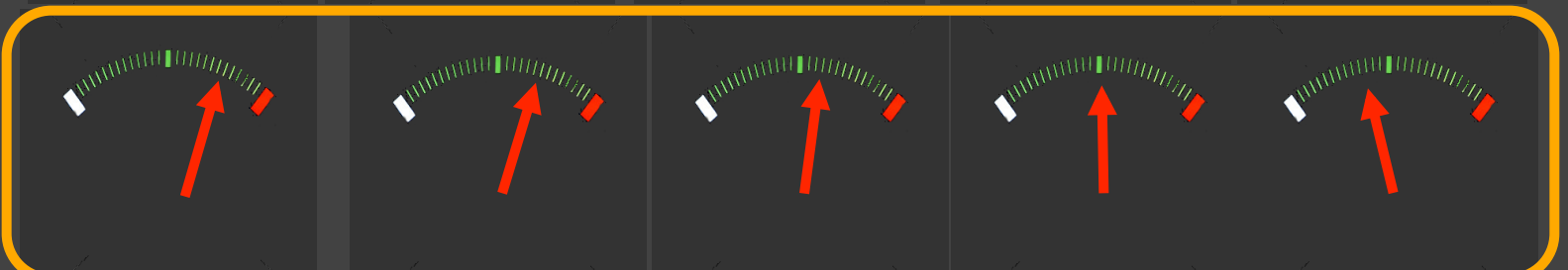


**Catastrophe  
Planet Crash**

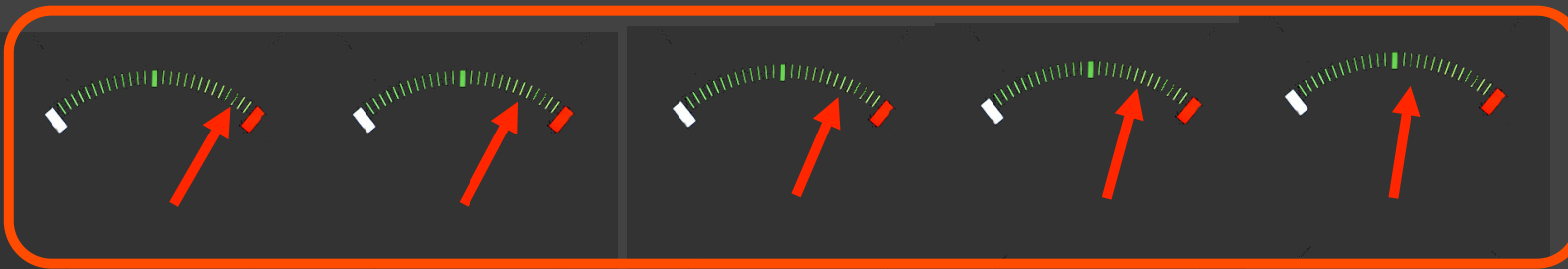
450 ppm



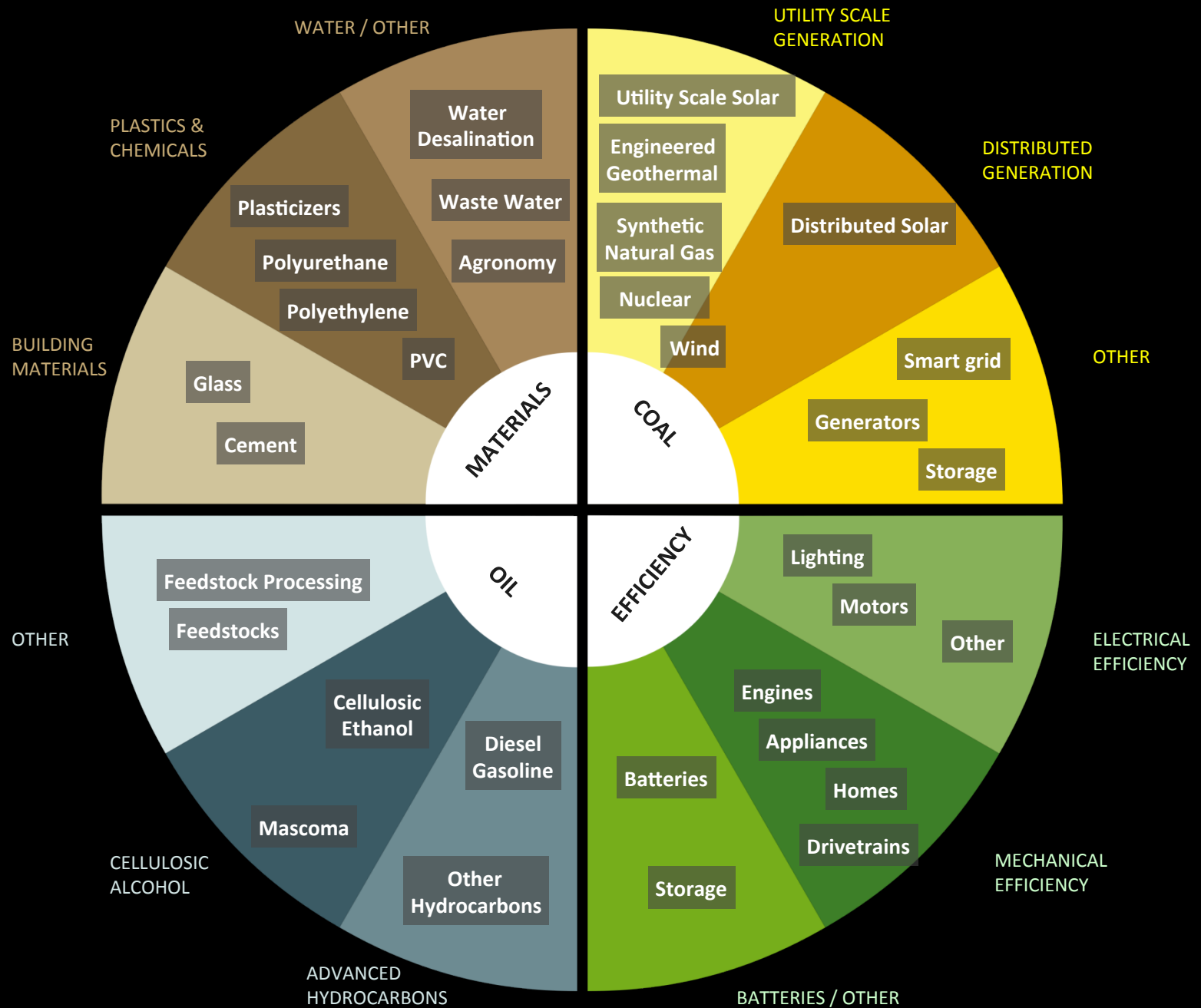
550 ppm



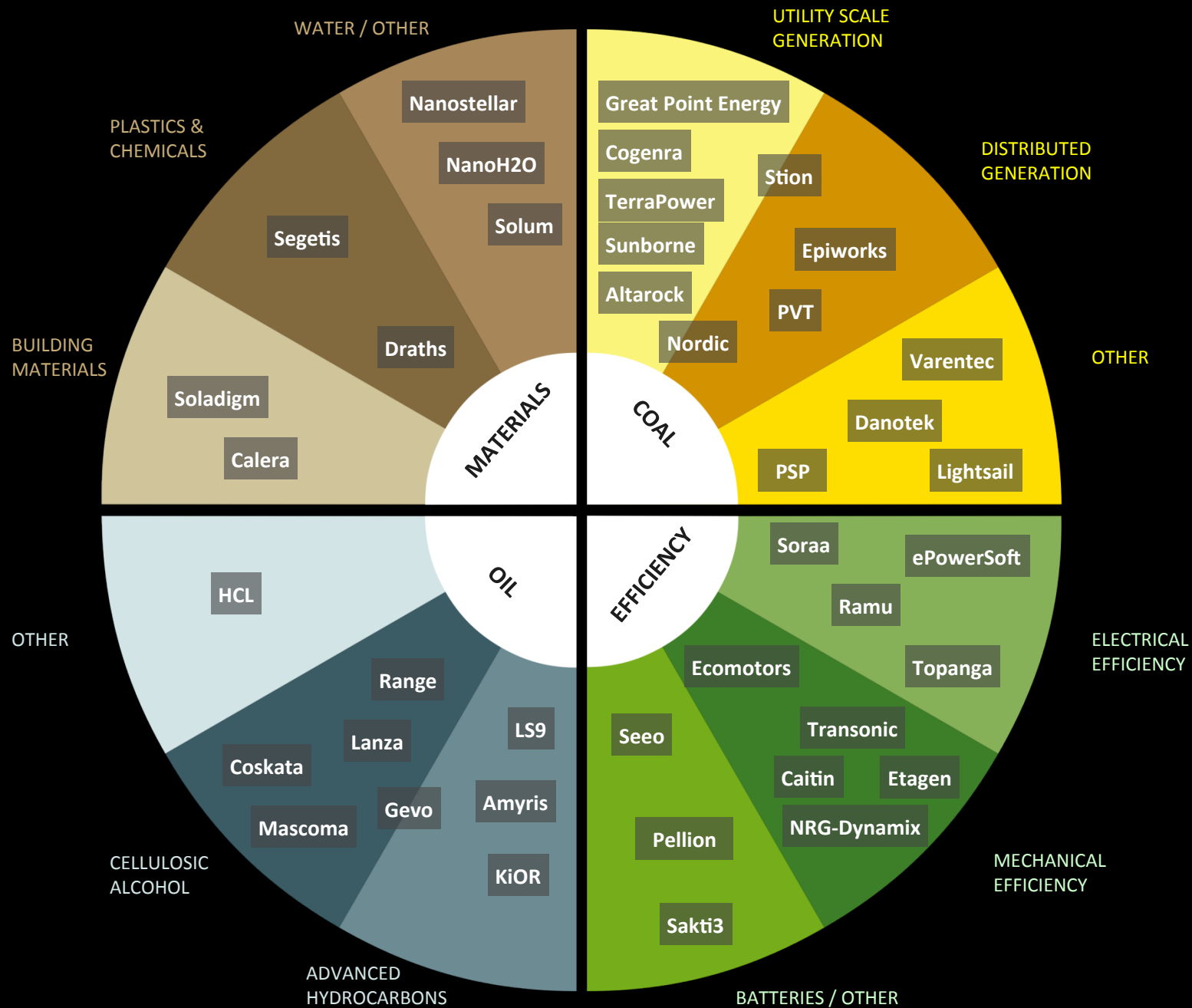
650 ppm



# khosla ventures green portfolio



# khosla ventures green portfolio



# Comments?

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