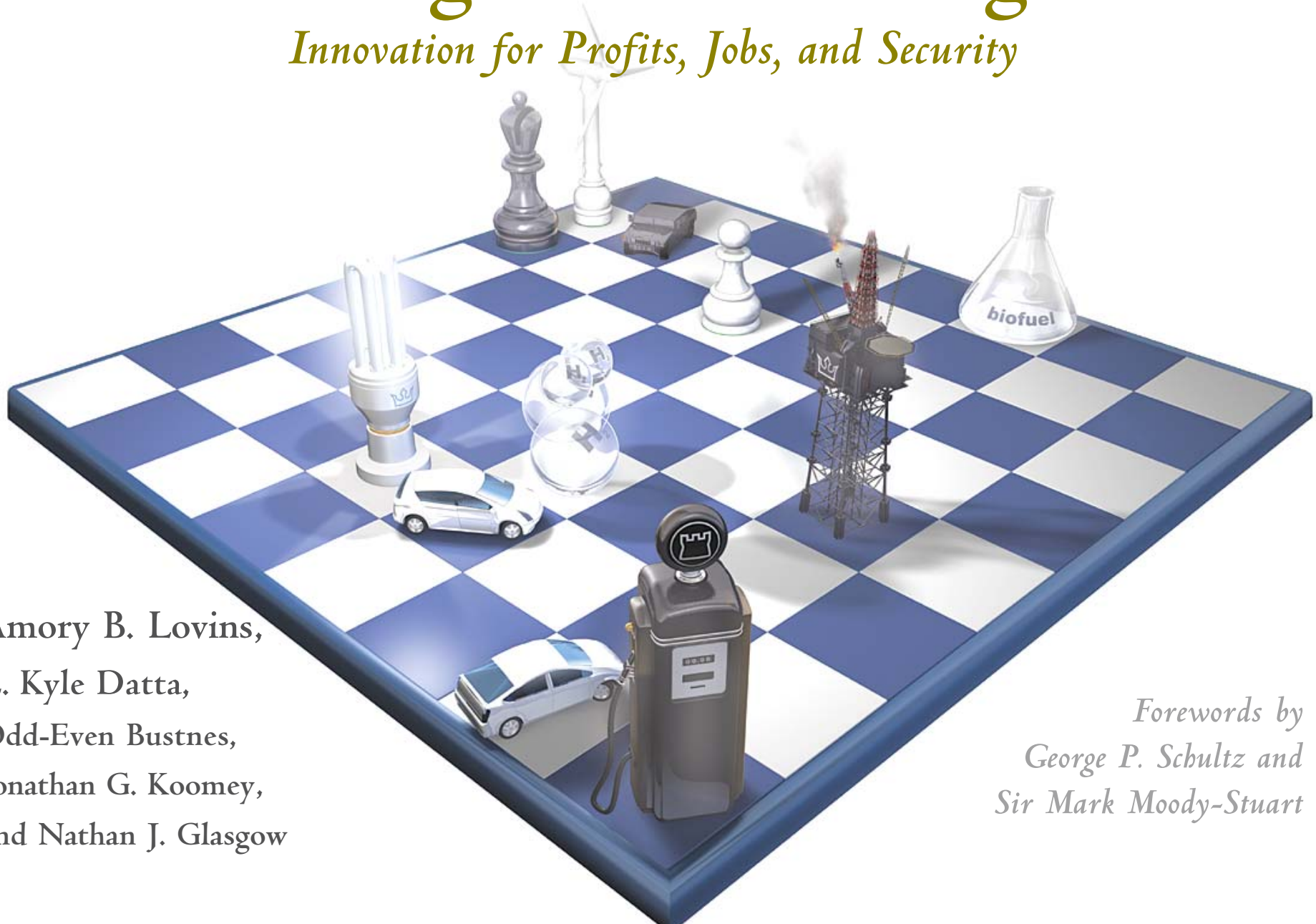
Winning the Oil Endgame

Innovation for Profits, Jobs, and Security



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Forewords by
George P. Schultz and
Sir Mark Moody-Stuart

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Over the next few decades, the United States can get completely off oil *and* revitalize its industrial and rural economy—led by business for profit.

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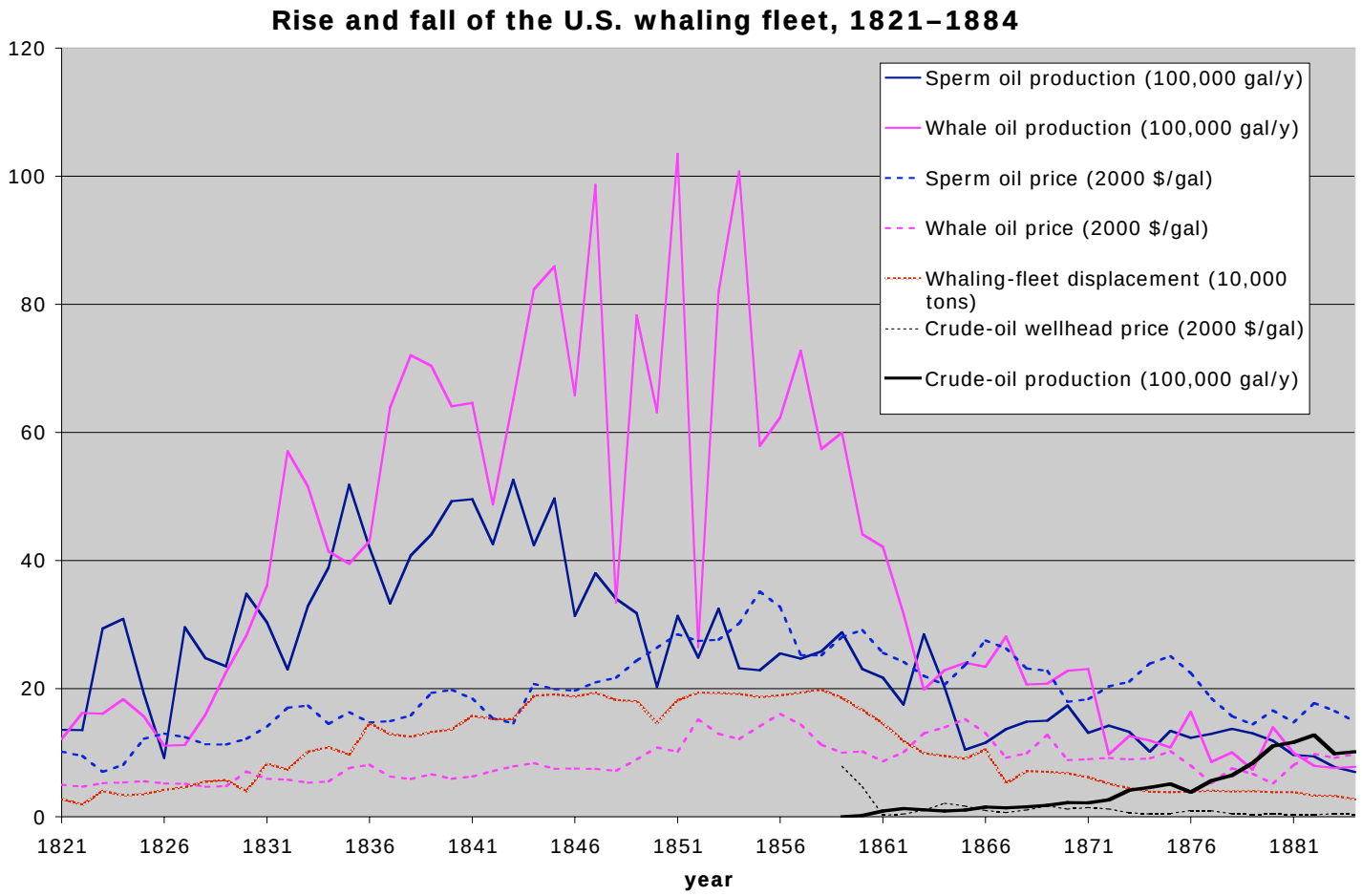
Whalers ran out of customers before they ran out of whales…



…even *before* Drake struck oil in 1859!

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Winning the Game: restoring competitiveness *and* eliminating oil dependence

- **National security *and* national competitiveness at risk**

Why should we care?

- **Oil insecurity, geopolitical rivalry, price volatility, perhaps depletion, climatic stability,…**
- **Japan, EU, China will eat Detroit for lunch; Airbus has overtaken Boeing; core economic sectors are at risk**

How do we win?

1. **Efficient end-use can save half the oil @ $12/bbl (2000 $)**
2. **Biofuels can cost-effectively substitute for another fifth**
3. **Saved gas can displace the rest, preferably via hydrogen**

Save net $70 billion a year by 2025, create a million net jobs

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How do we capture this prize?

- Invest $90 billion in transportation equipment industries, plus…
- $90 billion to build an advanced biofuels industry

→

- **Create 1 *million* good new American jobs (3/4 rural)**
- **Earn handsome returns**

- Business should lead, but…
- …needs acceleration, while…
- …expanding customer choice and reducing business risks

→

- **Support, not distort, business logic with new policies…**
- **Market-oriented without taxes**
- **Innovation-driven without mandates**
- **Reduce federal deficit**
- **Broad political appeal**

- Federal government: lead, follow, or get out of the way

→

- **Needs little or no Congressional action**
- **Can be administrative, or done by the states**

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$180 billion total investment for >$150 billion *annual return*

- The **$180 billion investment over 10 years** is small compared to our other choices: **$18 billion a year vs.:**
  - **$120 billion a year** in oil imports (largely wasted & the money lost)—that's **$18 billion every eight weeks**
  - **$40 billion a year** for Homeland Security, some oil-related
  - **$50+ billion a year** in peacetime military readiness for Gulf intervention (~2–3× what we pay to *buy* oil from the Gulf); increasing oil-protection burdens on all Commands
- **>$150 billion a year** in societal value by 2025
  - **$133 billion a year** in lower oil consumption (@ $26 a barrel)
  - **$10–30? billion a year** in military fuel logistics costs saved
  - **$0.5 billion a year** in unnecessary agricultural subsidies
  - **$11 billion a year** in carbon credit value

- **What's it worth to eliminate worries about oil's insecurity, volatility, and depletion? To regain the moral high ground? To have a safer world?**

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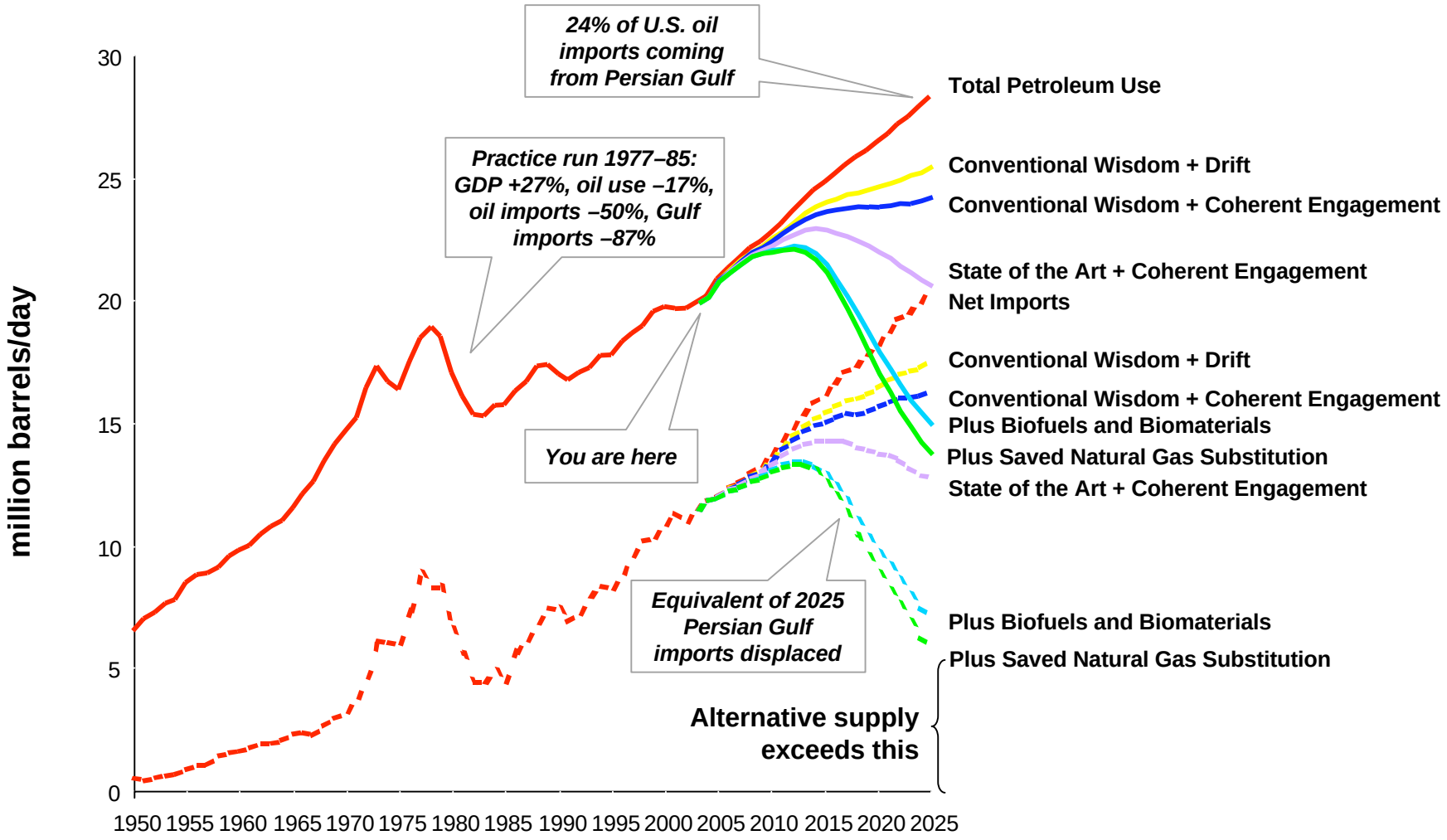
The energy future is choice, not fate

U.S. petroleum product consumption and net petroleum imports, 1950–2025



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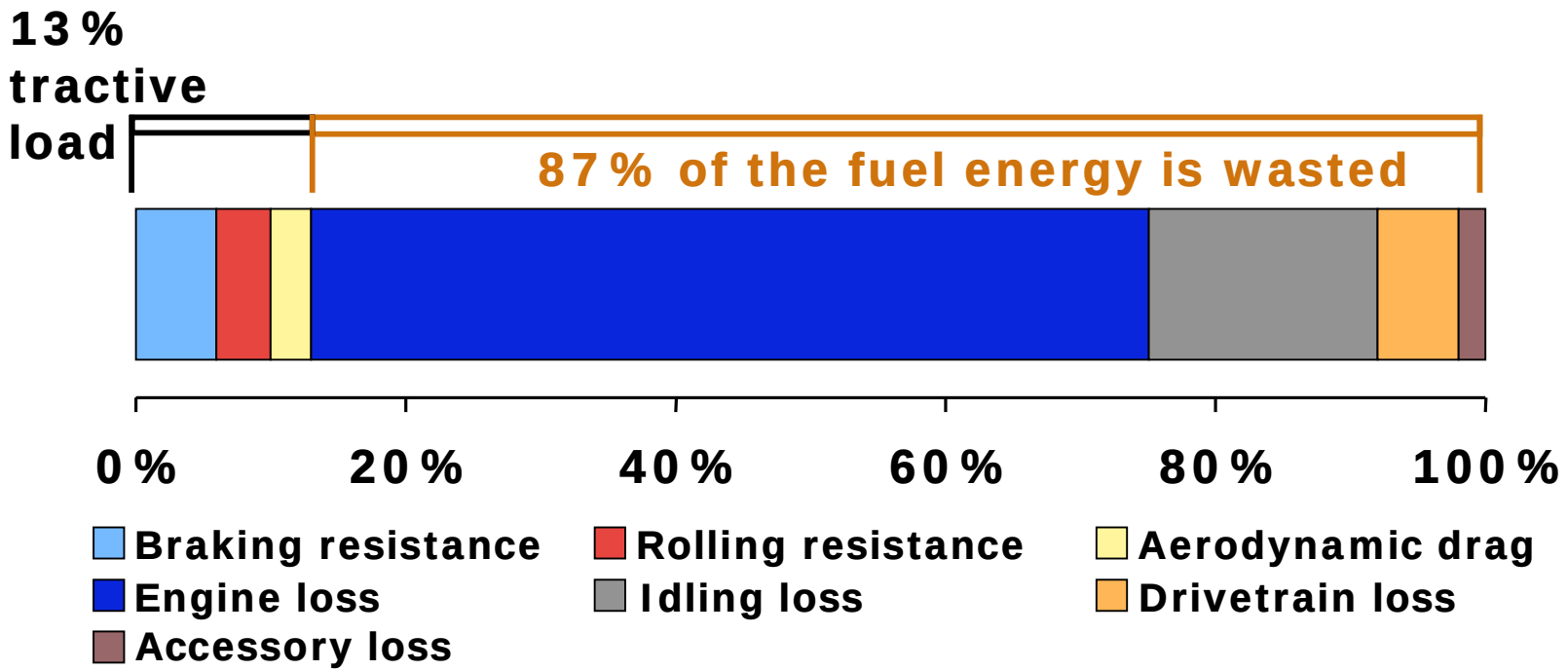
Where does a car's gasoline go?



- 6% accelerates the car, <1% moves the driver
- 2/3 to 3/4 of the fuel use is weight-related
- Each unit of energy saved at the wheels saves ~7–8 units of gasoline in the tank (or ~3–4 with a hybrid)
- **So first make the car much lighter!**

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Carbon fiber is strong but light

- **Carbon-composite crush structures can absorb 6–12× as much energy per pound as steel**
- **This can make cars lighter *but* bigger *and* safer… *and* simpler and potentially cheaper to manufacture**

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Light vehicles: 46% of 2025 oil use, 58% of 2000–25 oil growth

- 4× efficiency can be affordable and uncompromised
- Halving weight yields 68% of fuel saving in SUV
- Ultralight materials: advanced (mainly carbon-fiber) composites, w/ ultralight steels as backstop
  - Superior safety: materials and design compensate for light wt.
  - Comparable automaking cost with emerging mfg. processes (BMW, Fiberforge™,…): http://autofieldguide.com/articles/080407.html
  - Order-of-magnitude lower parts count, ≥2/5 less investment
  - No body shop, optional paint shop; no rust or fatigue
- Integrated ultralight design nearly redoubles the efficiency of today's 2× hybrids, at no extra cost
  - E.g., 66-mpg SUV, 92-mpg family sedan, w/3-y paybacks
  - But NHTSA is about to reward heavy & penalize light materials

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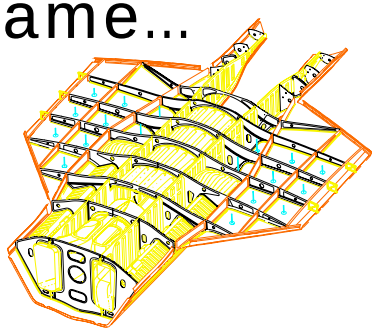
Migrating innovation from military aerospace to civilian cars

◇ At the Lockheed Martin Skunk Works®, engineer David Taggart led a ’94–96 team* that designed an advanced tactical fighter-plane airframe…



- made 95% of carbon-fiber composites
- 1/3 lighter than its 72%-metal predecessor
- *but 2/3 cheaper*…
- because it was designed for optimal manufacturing from composites, not from metal

*Integrated Technology for Affordability (IATA)

◇ Finding no military customer for something so radical, he left. I soon hired him to lead the 2000 design of an halved-weight SUV with two Tier Ones: 66 mpg gasoline-hybrid, 114 mpg H_2-fuel-cell, 0–60 mph in 8.2 s, crashworthy, affordable

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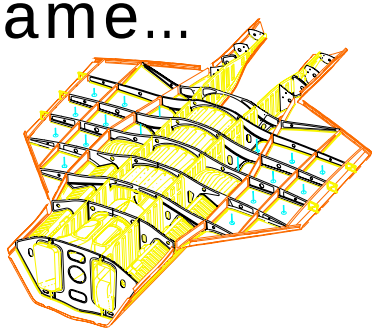

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"We'll take two."

— *Automobile* magazine

Midsize 5-seat-SUV (2000)
Ultralight but ultrasafe
0–60 mph in 8.2 s
66 mpg w/gasoline hybrid
114 mpg-equiv.
w/H_2 fuel cell

Show car and a complete virtual design (2000), uncompromised, production-costed, and manufacturable at competitive cost

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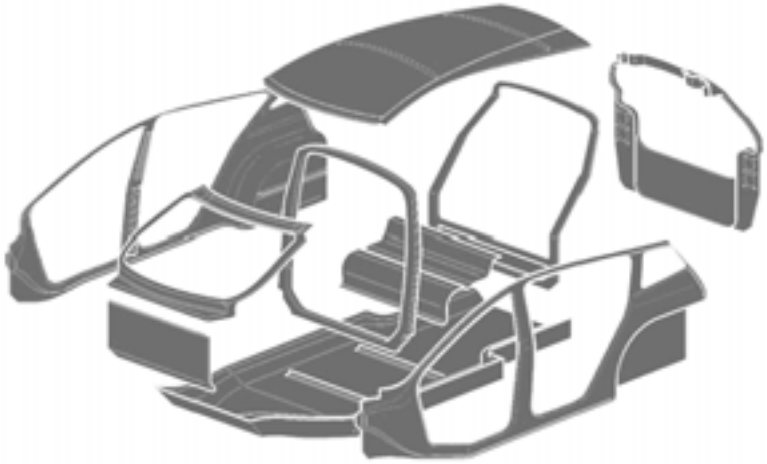
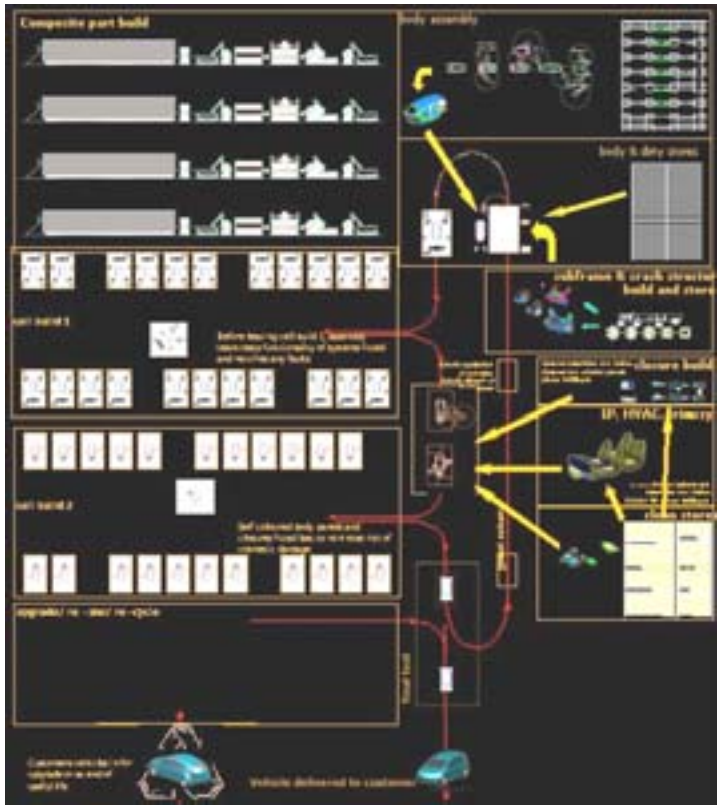
Radically simplified manufacturing

- Mass customization
  - *Revolution* designed for 50k/year production volume
  - Integration, modular design, and low-cost assembly
  - Low tooling and equipment cost





  - 14 major structural parts, no hoists
  - Self-fixturing, detoleranced in 2 dim.
  - No body shop, optional paint shop
  - Cosmetic nonstructural exterior panels

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The future is already here: today's concept vehicle approaches will be tomorrow's mainstream …

CARS: save 69% at 57¢/gal

PLANES: save 20% free (*7E7*), 45% @ 46¢/gal

BLDGS/IND: big, cheap savings; often *lower* capex

TRUCKS: save 65% @ 25¢/gal

Technology is improving faster for efficient end-use than for energy supply

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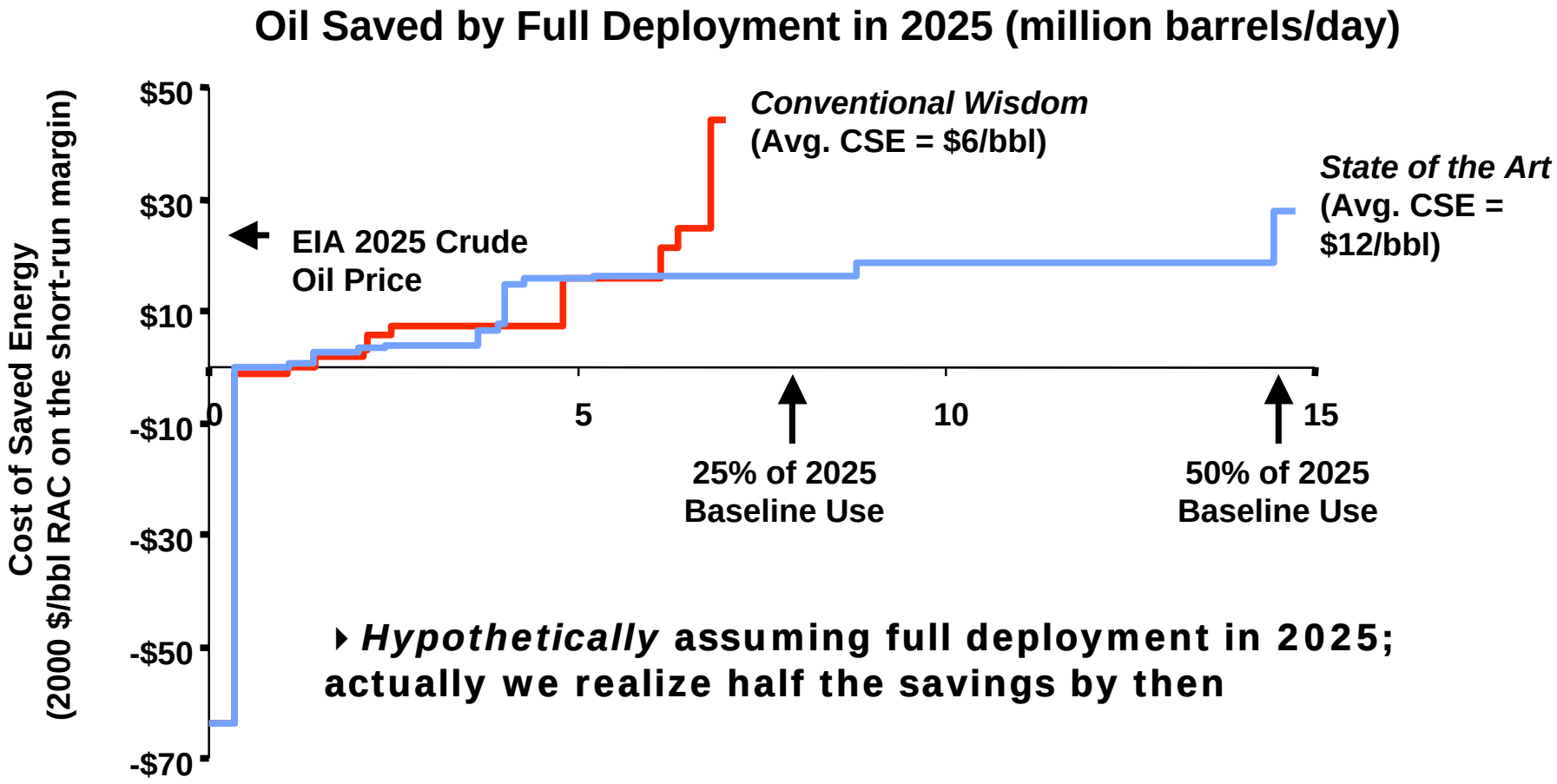
It pays to be bold: incremental *CW* technologies can save 26% of oil use cheaply ($6/bbl), but *State of the Art* technologies can (if fully used) save 52% of 2025 oil for only $12/bbl



- ***Hypothetically*** **assuming full deployment in 2025; actually we realize half the savings by then**

Conservatisms include no new technologies: *State of the Art* is as developed by 2004, not by 2025

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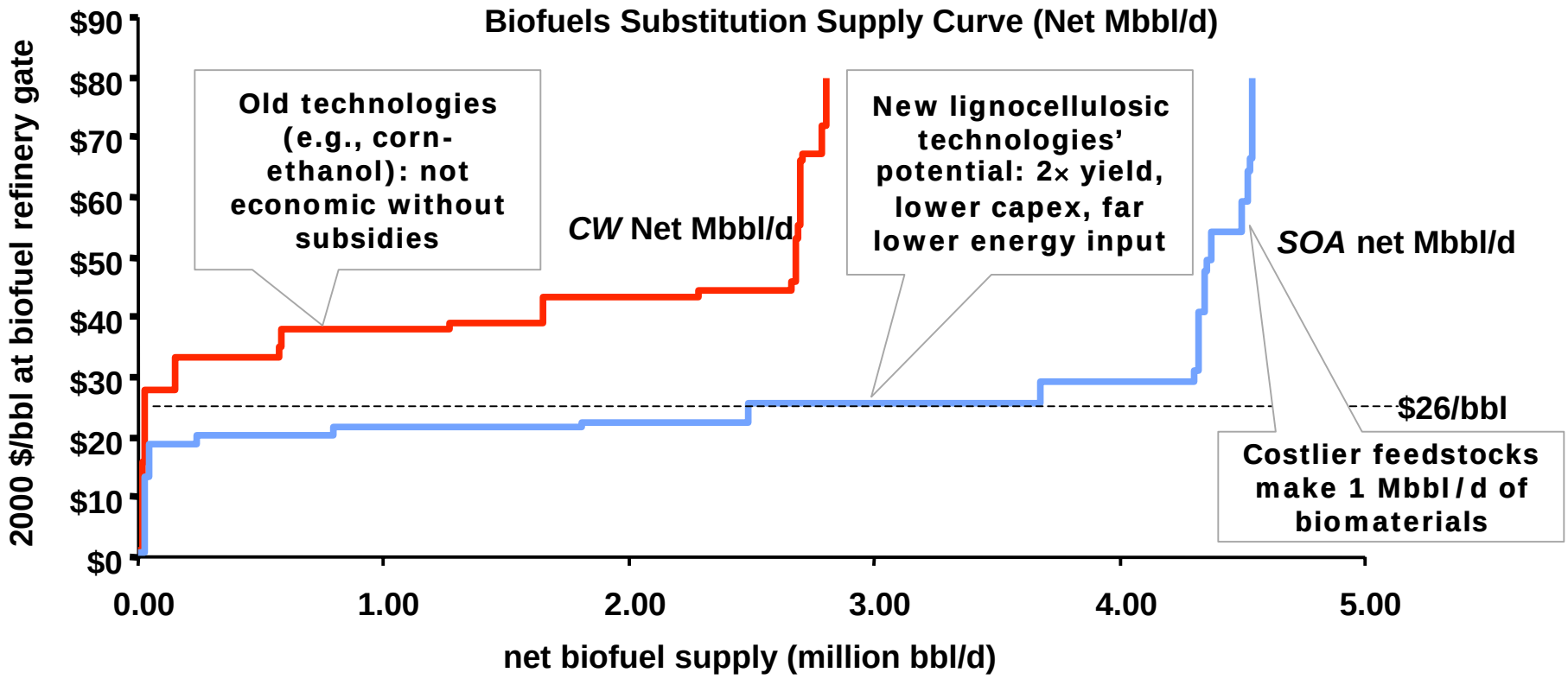
New biofuel technologies could provide 3.7 Mbbl/d cheaper than oil—without subsidies or crop/land/water problems



- Brazil has replaced 1/4 of its gasoline with sugar-cane ethanol, competitive without subsidy; oil savings so far are 50× the startup subsidy; exporting increasingly to Japan and China
- Europe in 2003 made 17× as much biodiesel as U.S.: oil companies distribute it; shifts farmers from subsidy to revenue

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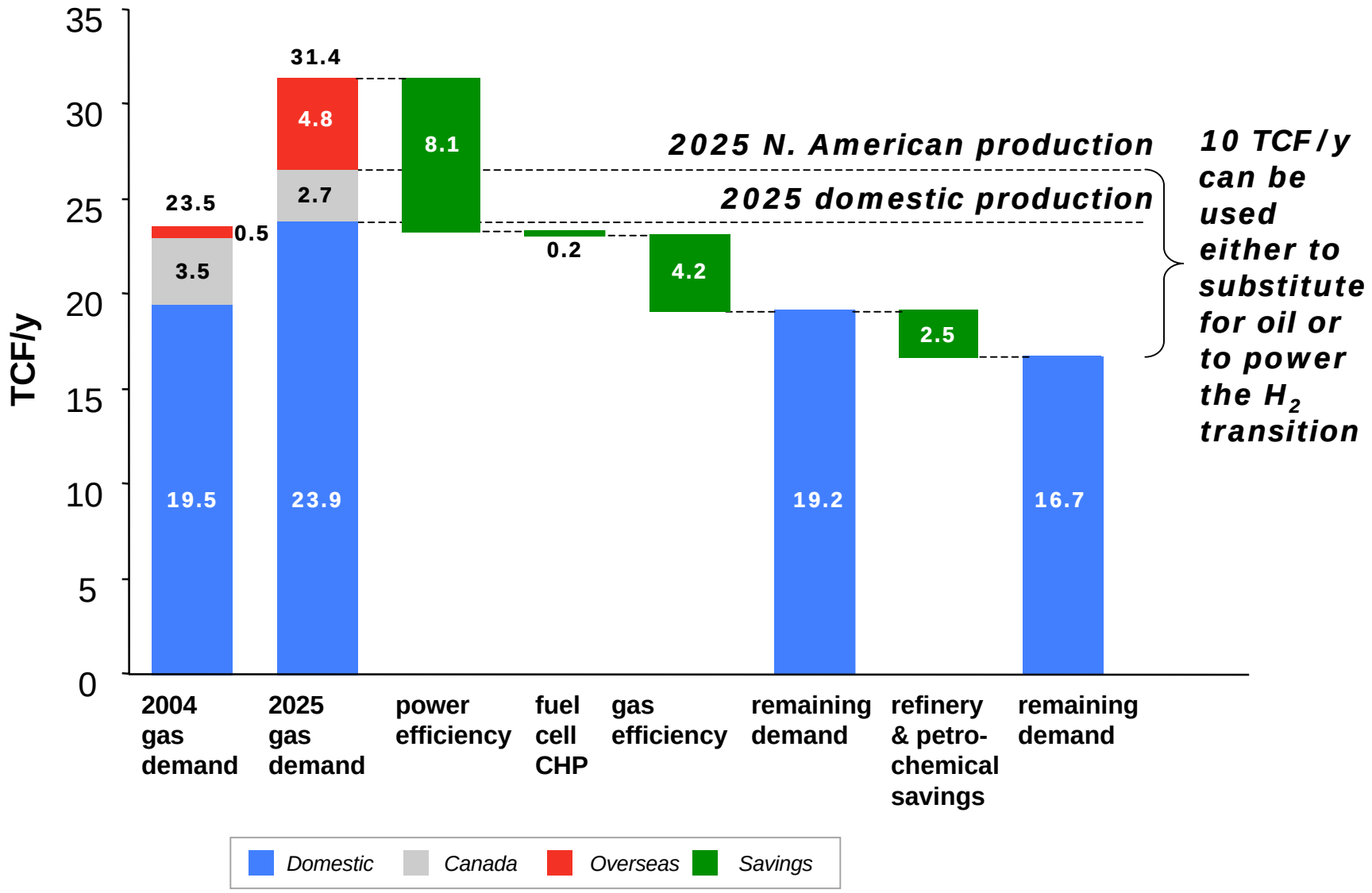
Over 12 TCF/y of natural gas could be saved by lucrative energy efficiency



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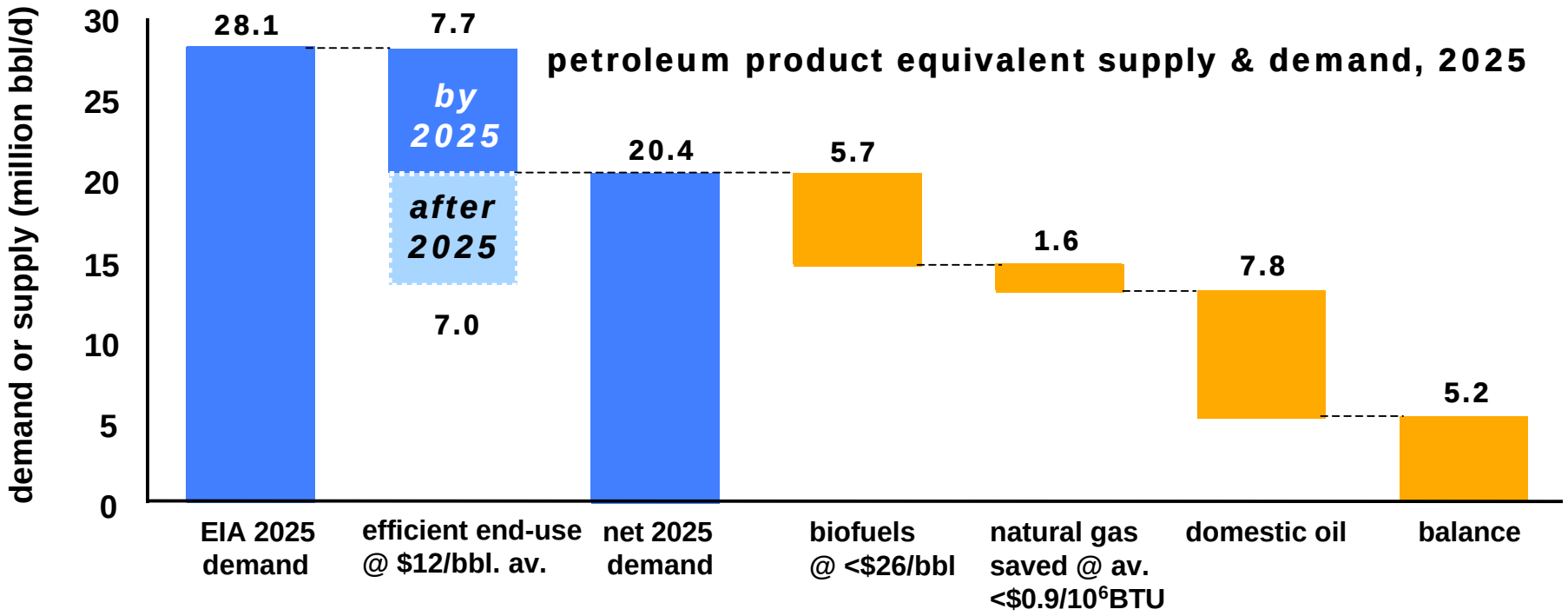
2025 demand-supply integration



Great flexibility of ways and timing to *eliminate* oil in next few decades

- **Efficiency shown costs only $12/bbl av., vs. $26 for 2025 oil (assuming zero externalities), so shouldn't we buy even more efficiency?**
- **Efficiency is only half captured by 2025: another 7 Mbbl/d, more than "balance," remains to be saved soon thereafter**
- **"Balance" can import crude oil/product (can be all N. Amer.) or biofuels**
- **H_2 from leftover saved U.S. natural gas can displace "balance" + dom.oil**

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Four basic market failures

- Oil is priced below its societal cost
- Most customers are very short-sighted
- Most customers have poor information
- Most managers resist disruptive innovations

Policy portfolio must turn these obstacles into business opportunities and accelerate adoption of advanced-technology vehicles

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Five ways government can help

1) **Stimulate demand for very efficient vehicles**
   - Feebates—revenue- and size-neutral, more automaker profit
   - Create a new million-car-a-year market through leasing to low-income customers (and scrapping clunkers)
   - Smart military and government fleet procurement; “Golden Carrot” and “Platinum Carrot” to speed innovation
   - Heavy-truck-buyer info/leadership, airline loan guarantees
2) **Build vibrant 21st Century industries by sharing R&D risk and deploying faster than the private market**
   - Military S&T should finance advanced materials development
3) **Lower risk of investment for new manufacturing plants through loan guarantees to automakers**
4) **Support development of domestic energy supply infrastructure (hydrocarbons → carbohydrates)**
5) **Remove barriers to efficiency through coherent policies and purging perverse incentives**

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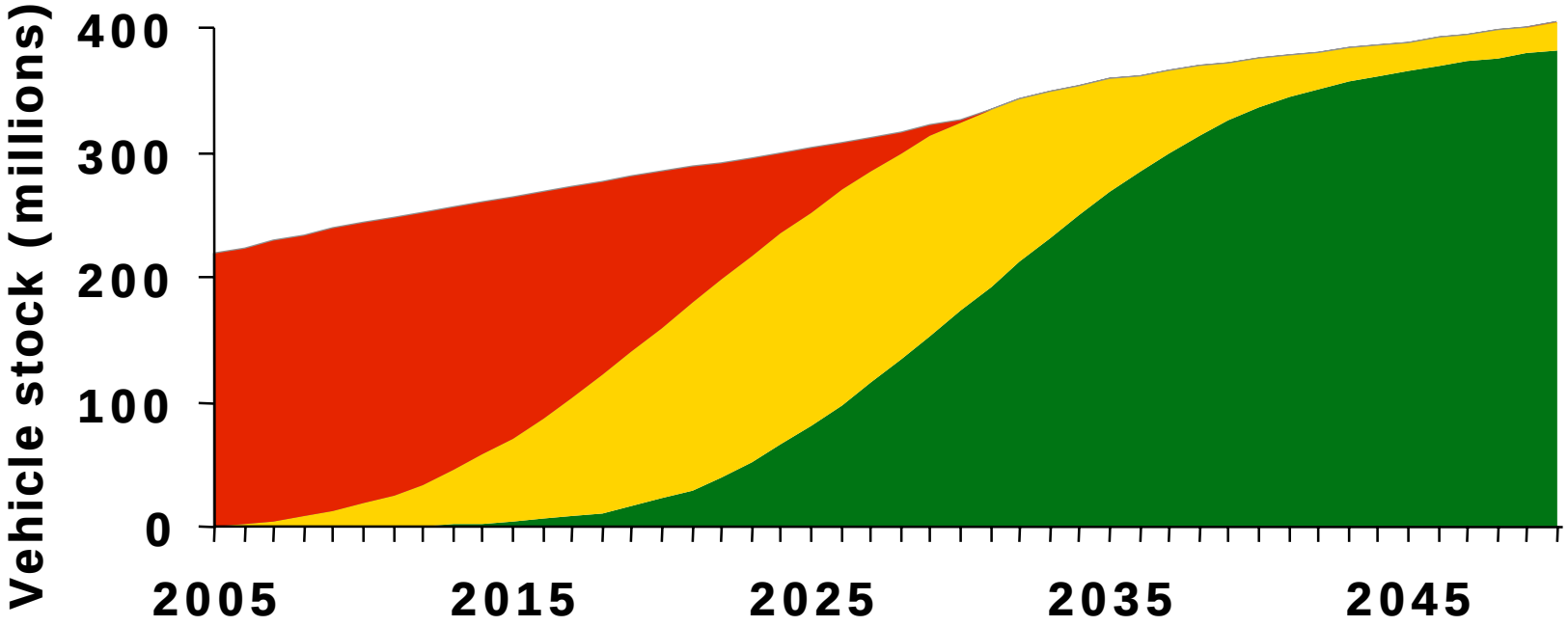
Mobilization: Accelerating Change

4.5 Mbbl/d saved, $391 billion in retail fuel savings



Average Vehicles (rather like today's cars)

Conventional Wisdom (27% more efficient, 1-y payback)

State of the Art (ultralight hybrids)

90–100% *State of the Art* vehicles by 2040

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Big, fast changes have happened

- U.S. automakers switched in **SIX YEARS** from 85% open wood bodies to 70% closed steel bodies—and in **SIX MONTHS** from making four million light vehicles per year to making the tanks and planes that won World War II
- Major technological transformations take **12–15 years** to go from 10% to 90% adoption
- The key is to get to the first 10% much faster!
- In 1977–85, U.S. cut oil intensity 5.2%/y—equi-valent, at a given GDP, to a Gulf every 2.5 years
- If every 2025 light vehicle were as efficient as the best 2004 cars & SUVs, they'd save 2 Gulfs' worth

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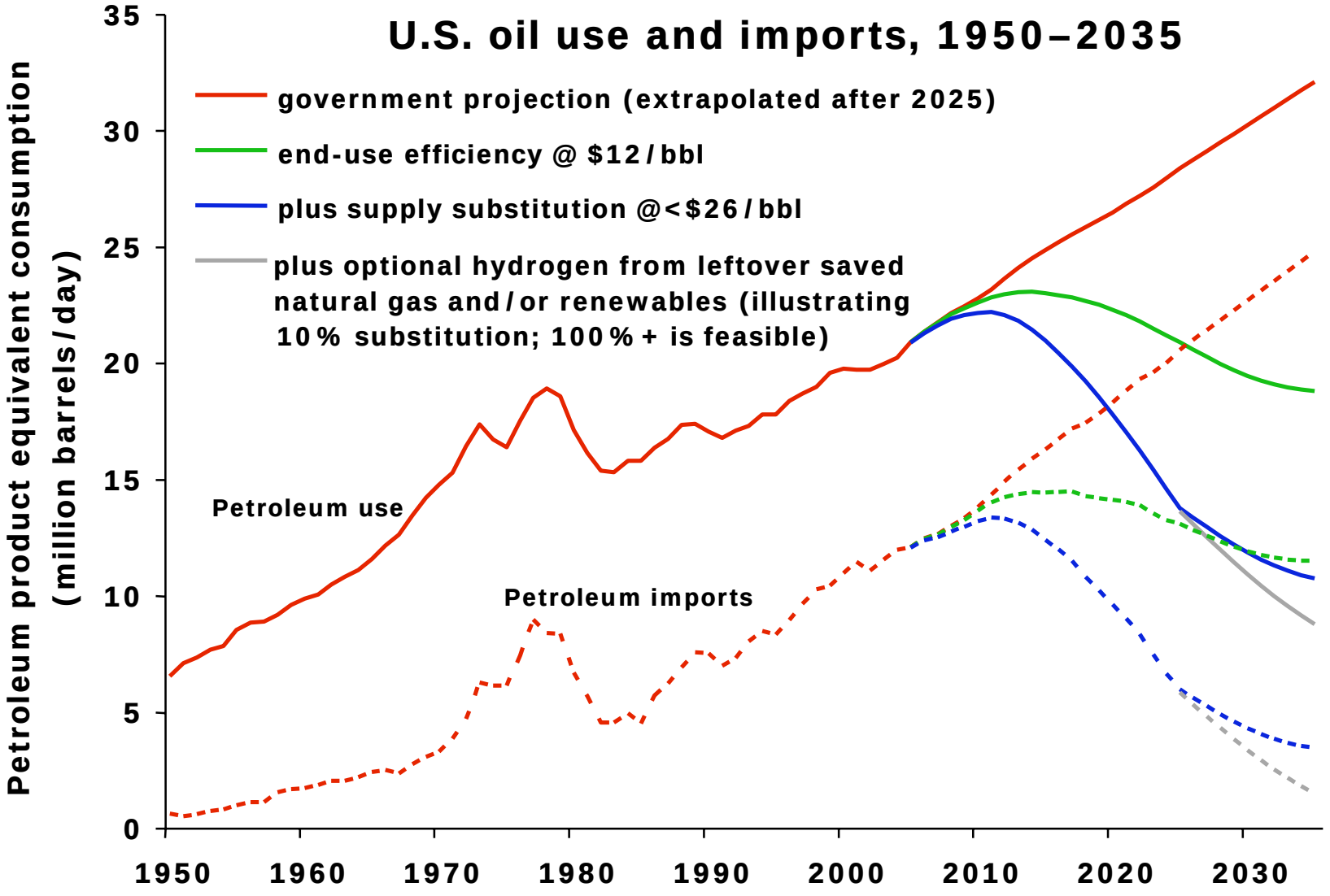
A profitable U.S. transition beyond oil



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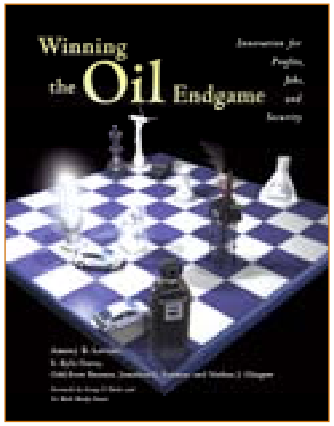
Why should you care enough to act?

What are we waiting for?

Let’s play the Oil Endgame to win.



Free download from www.oilendgame.com

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