Hell and High Water: Global Warming— The Problem and the Solution

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Our Top Climate Scientist Warns

- "We are on the precipice of climate system tipping points beyond which there is no redemption." (12/05)
- "I think we have a very brief window of opportunity to deal with climate change ... no longer than a decade, at the most." (9/06)

— James Hansen, director of NASA's Goddard Institute of Space Studies

Summary: Ice Sheets (Hansen, 06)

1. **Human Forcing Dwarfs Paleo Forcing**

2. **Sea Level Rise Starts Slowly as Interior Ice Sheet Growth Temporarily Offsets Ice Loss at the Margins**

3. **Equilibrium Sea Level Response for ~3C Warming (25±10 m = 80 feet) Implies Potential for a System Out of Our Control**

If We Delay Acting …

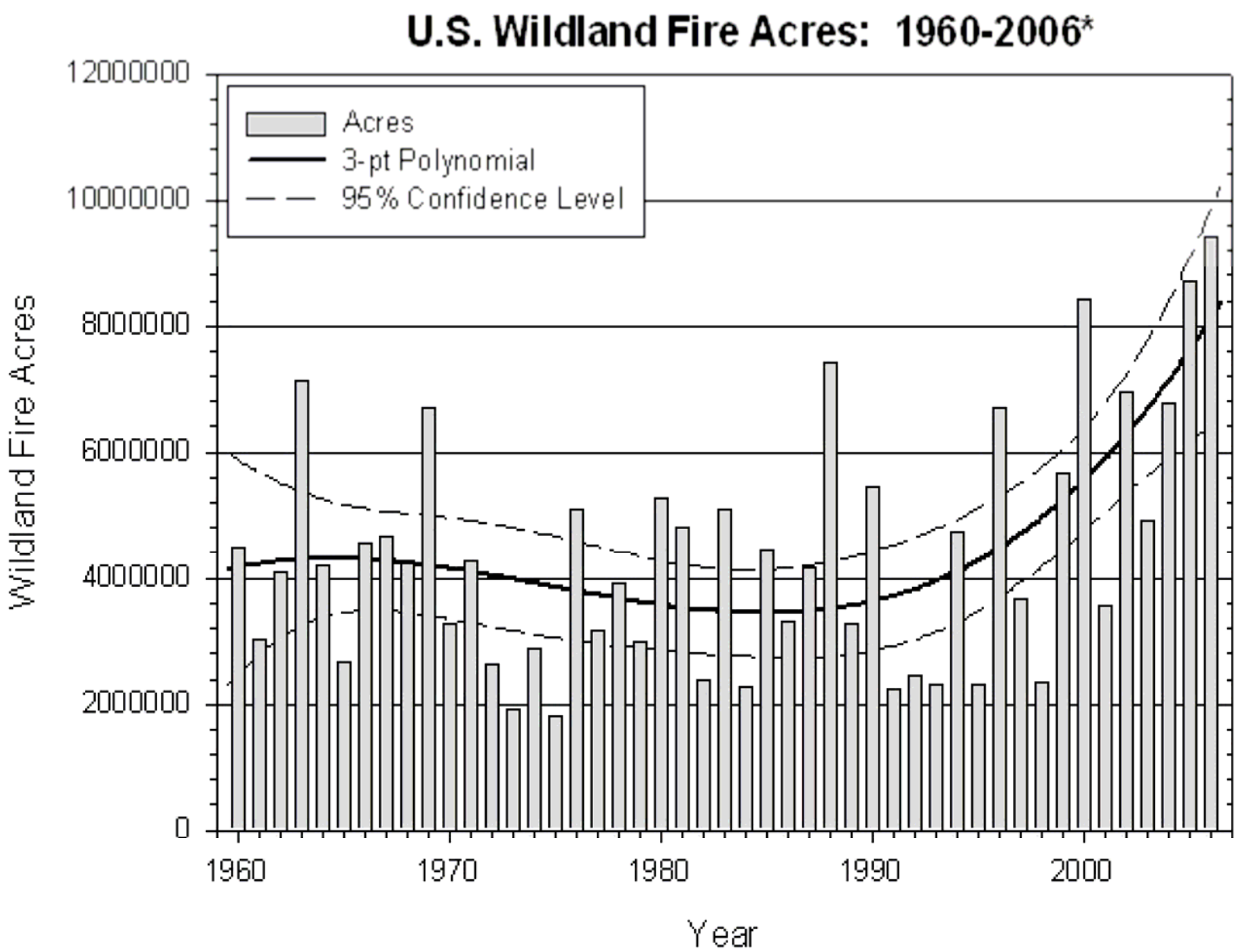
- When will coastal property values crash

  because of impending storms and sea level rise?
- When will we end the manned space program

  because we have to focus $$$ on climate?
- When will we lose all soft power

  because we are a global pariah?
- When will biofuels disappear as an option

  because drought forces a focus on land for food?


U.S. Wildland Fire Acres: 1960-2006*
Acres
3-pt Polynomial
95% Confidence Level
Wildland Fire Acres
12000000
10000000
8000000
6000000
4000000
2000000
0
1960
1970
1980
1990
2000
Year

THE CENTURY OF DROUGHT

- "… moderate drought, currently at 25% of the Earth's surface, rising to 50% by 2100 … and *extreme drought, currently 3%, rising to 30 per cent.*" — UK's Hadley Centre for Climate Prediction and Research (10/06)
- Suggests that if we delay acting, most available land post-2050 will be **needed for food, not biofuels.**

We MUST save the Tundra

- The tundra has as much carbon locked in it as the atmosphere.
- Much of it is methane (CH4), which traps 20 times the heat of CO2.
- Tundra loss ~60% at 550 ppm (NCAR-2005)
- Stabilizing at 550 ppm (a “doubling”) may just be wishful thinking.

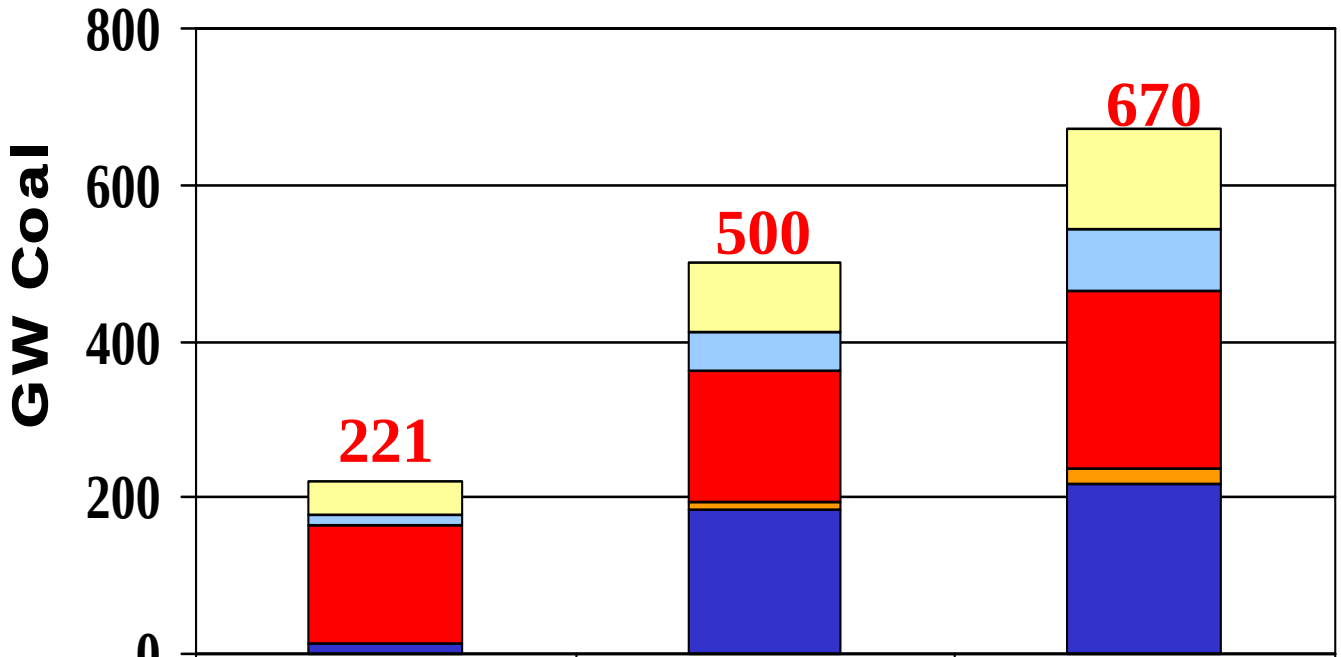
TIME FOR DELAY HAS RUN OUT

- We’re at 380 ppm CO2, rising 2+ ppm/yr
- If 500 & rising in 2050, plan on 700+ in 2100
- 550 ppm = 3+°C warmer = plan for 80-ft sea rise
- Global emissions *must* peak ~2025
- We *must* cut CO2 emissions >50% by 2050.
- We *must* stop building traditional coal plants
- We *must* have average new car *60 mpg* in 2040

Dealing with Coal *and* Cars

- Coal strategy
  - Minimize new coal builds with efficiency
  - Replace coal with renewables, CO2 capture, etc.
  - Coal-biomass blending for gasification
- Car strategy
  - Fuel efficiency for 20+ years
  - Then need low-CO2 fuel that won't undermine efforts to deal with coal
  - Best alt fuels minimize new infrastructure

New Coal Build by Decade



	2003-2010	2011-2020	2021-2030
Other Developing	43	90	128
India	16	48	79
China	150	168	226
Transition	1	11	19
OECD	12	184	218

>$1 *trillion* in misallocated capital

Source: IEA, WEO 2004

NRDC
THE EARTH'S BEST DEFENSE

Unconventional Oil is Climate Disaster

- Tar Sands: Use CH4 to make C-intensive fuel
- Coal-to-Oil: Double the CO2 emissions
  - Still a bad idea with carbon capture
- Enhanced Oil Recovery diverts captured CO2
  - Should NOT be valued as geologic storage
- Shale: 1.2 GW for 100,000 barrels a day

The Hype About Hydrogen

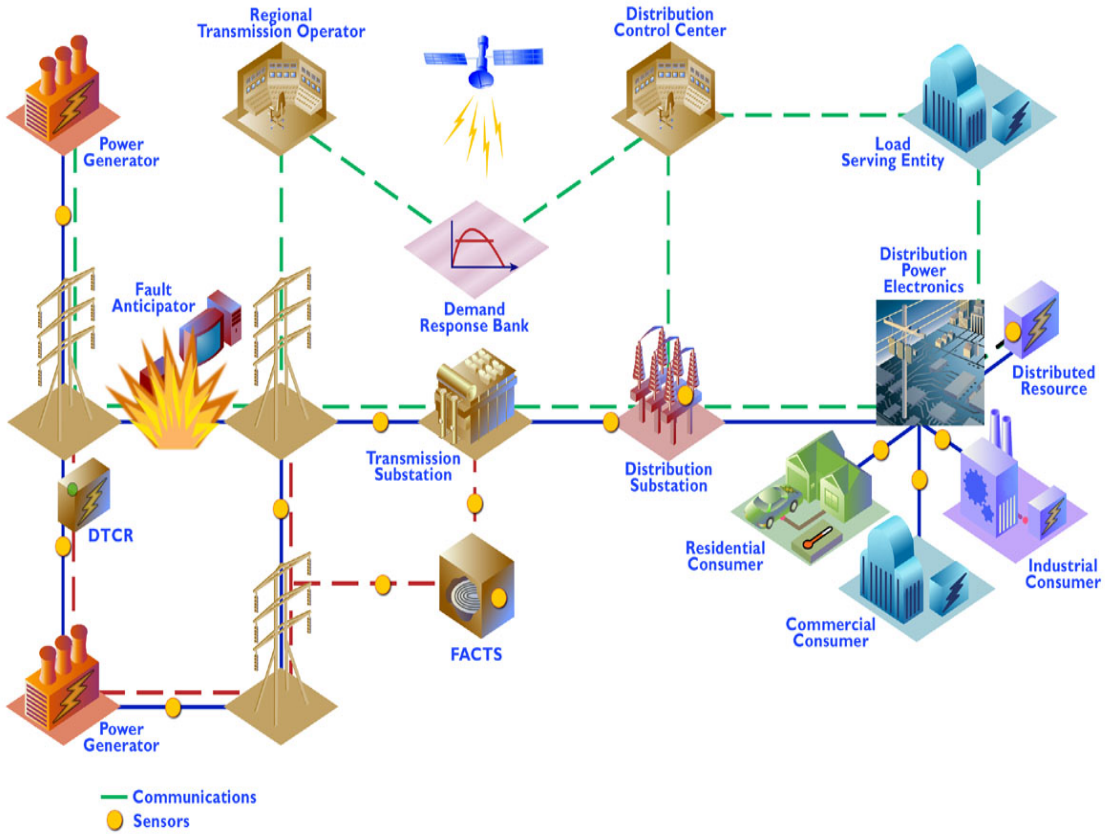
- "Total time to noticeable impact … is likely to be more than 50 years." —Heywood, MIT, 7/05
- "If I told you '**never**,' would you be upset?"

  Toyota's Bill Reinert on when H2 replaces gas, 1/05
- "Forget hydrogen, forget hydrogen, forget hydrogen." — James Woolsey, 1/06
- After "CO2 emissions from electricity generation are virtually eliminated…." — *Science*, 7/03

Car of the Future: Plug in Hybrids

- 20-mile electric range, then reverts to hybrid
- Could displace half of gasoline
- Works best with carbon cap
- Blend in cellulosic ethanol
- Why use future clean electricity for H2?
  - Plug in uses electricity *3 to 4 times more efficiently*
  - Make use of existing infrastructure/vehicles
  - A Boon for Utilities: Load balancing, etc.

Smart (Intelligent) Grid



OBJECTIVES:

Self-Healing and *Adaptive*

Interactive with consumers and markets

Optimized to make best use of resources and equipment

Predictive rather than just reacting to emergencies

Distributed across geographical and organizational boundaries

Integrated, merging monitoring, control, protection, maintenance, EMS, DMS, marketing, and IT

More Secure from attack

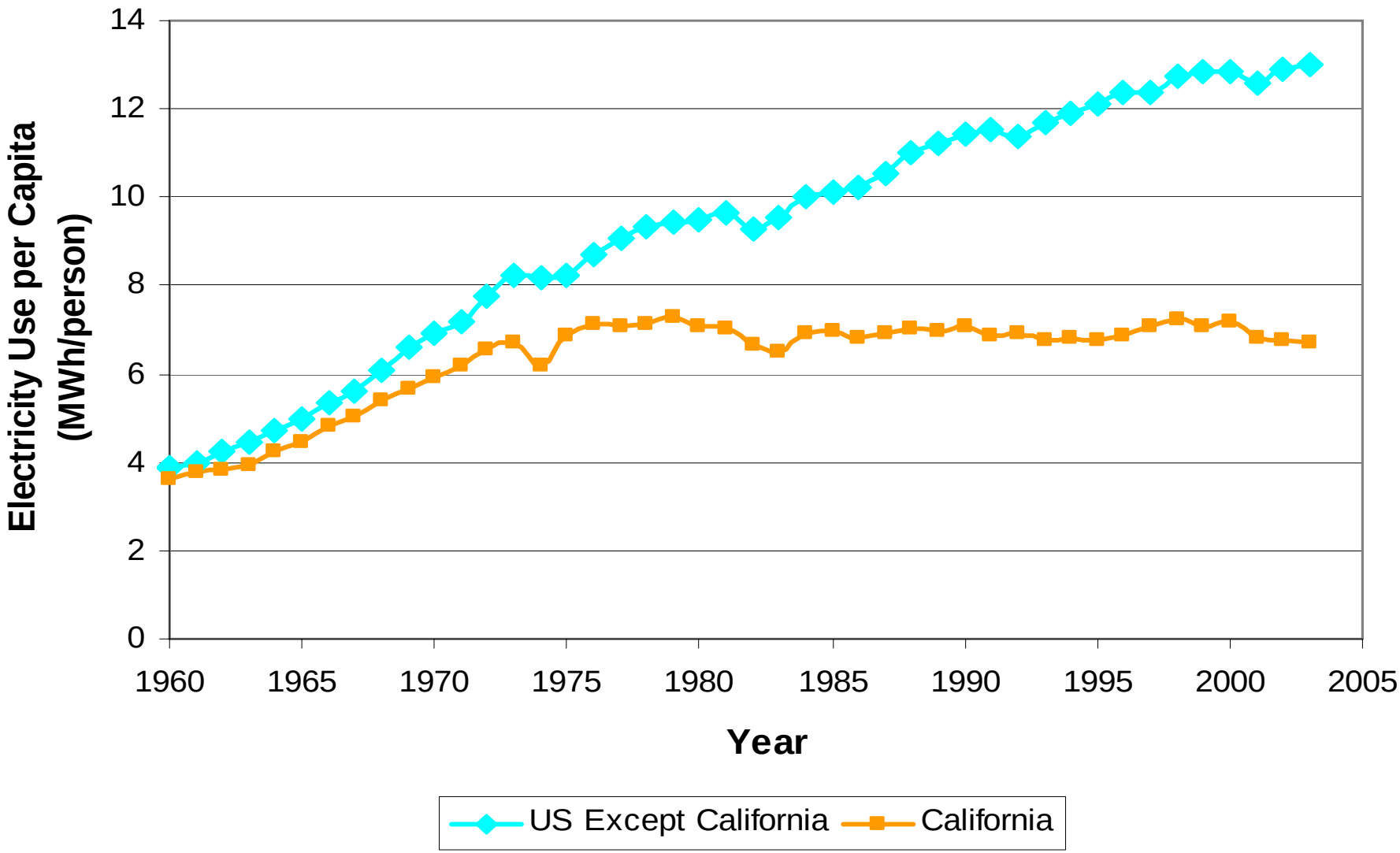
Eco-Benefit of Intelligent Grid

- Enabling PHEVs
  - Potentially its biggest benefit
- Enabling demand response
  - Modest net efficiency gains
  - Need smart meters
- Enabling DG
  - Post-2020 GHG benefits are limited

Key Trends for Stationary Fuel Cells

- Price and payback rules for all DG
  - Still $4000+/kw and run on CH4
- FCs very good on criteria pollutants
- FCs so-so on GHGs
  - Must be *efficient* AND must *cogenerate*
  - → Solid Oxides (SOFCs), not PEMs
- Should not be overhyped by enviros

Figure 4: What Energy Efficiency Can Really Do

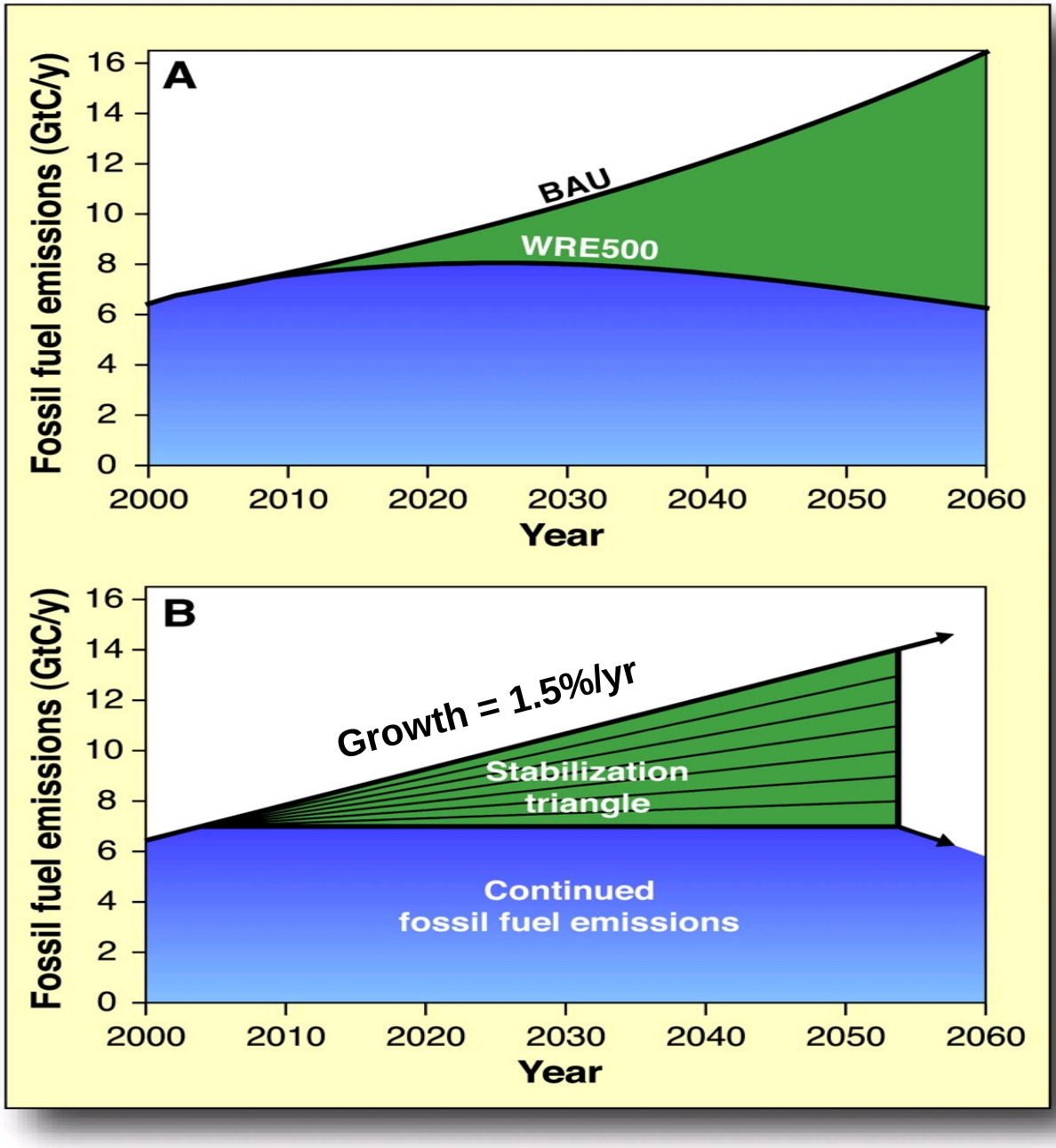


LED Lighting

- Huge R&D investment (laptops, cell phones)
- Very Pricey for general lighting today
- Useful & efficient in *some* applications today
  - Jefferson Memorial
  - Bank of American Signage
- Doesn’t beat the best fluorescents yet!

The Technologies to Watch

- Reduce energy/CO2 cost-effectively
- Equal or improve upon what they replace
- Do not require significant behavior change
- → Basic Efficiency, hybrids, PHEVs
- → Renewables, biofuels, IGCC + CCS?
- NO SILVER BULLETS
  - Pacala & Socolow: Stabilization Wedges (8/04)



Source: Stabilization Wedges: Pacala and Socolow, Science Vol 305, page 968

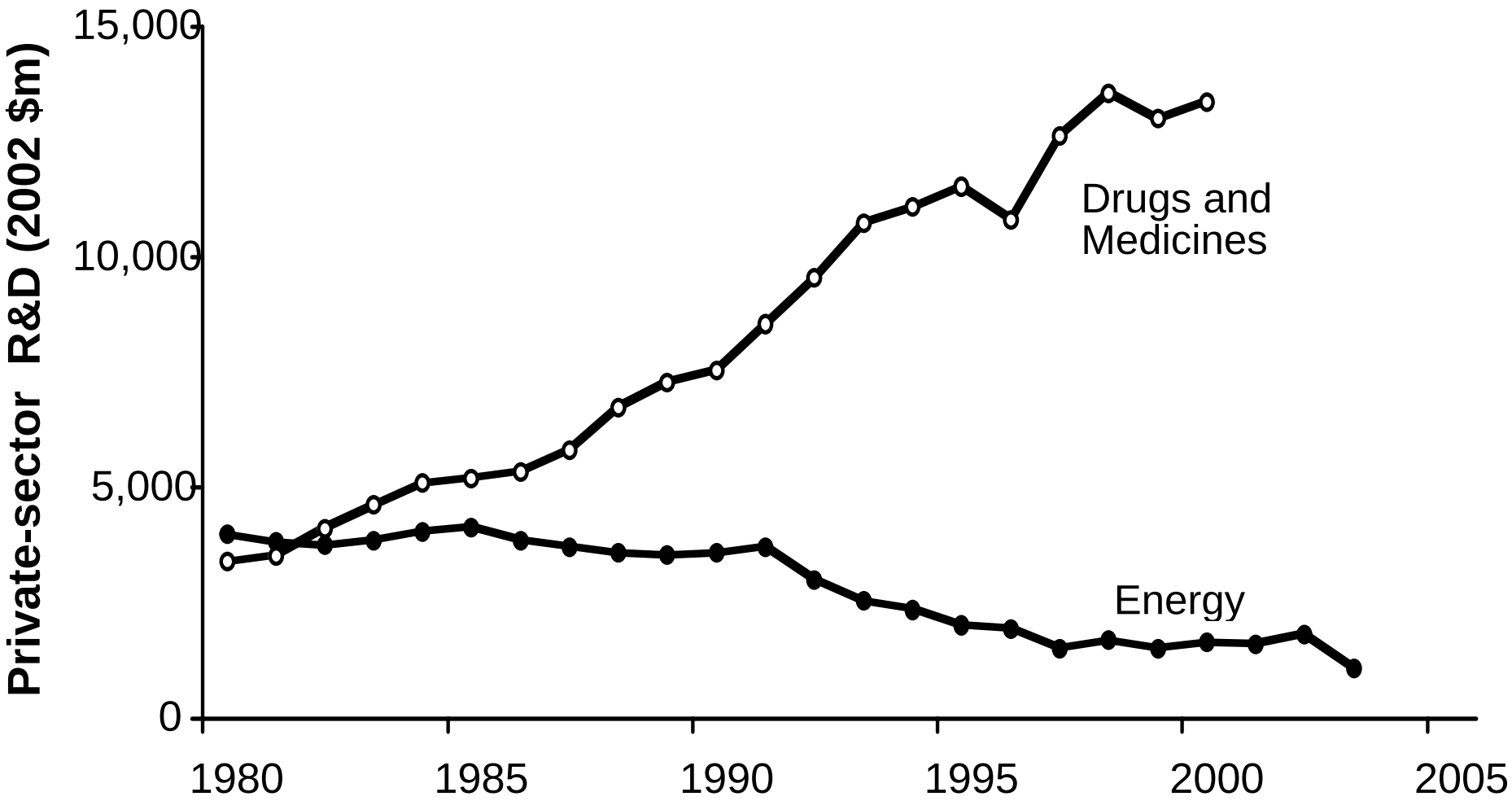
Avoiding Climate Catastrophe WEDGES: 2010 to 2060

- California-style program for building efficiency
- Similar program for industry efficiency plus cogen
- Carbon capture & storage for 800 GW coal
- Build 2000 GW of wind turbines (or equivalent)
- Build 700 GW new nuclear plants.
- All cars 60 miles per gallon.
- All cars flex fuel plug-ins (+ 1000 GW more wind and one-twelfth of world's cropland for biofuels).
- End all tropical deforestation. Double tree planting.

The Breakthrough Reality

- What technology breakthroughs in the past three decades have transformed how we use energy today?
- There haven't been any.
- "Typically it has taken 25 years after *commercial* introduction for a primary energy form to obtain a 1% share of the global market." — Royal Dutch/Shell 2001

Private Sector R&D Investment in Health and Energy



Kammen and Nemet, 2005

The Gravest Security Threat to our Way of Life for **50 Generations**

- We need a World War II-scale effort ***now***
  - Efficiency, Efficiency, Efficiency
- It is only money!
- *Homo sapiens sapiens?*
- Climateprogress.org
- *Hell and High Water* at Amazon.com