

# Nightmare on Planet Earth: Our Multiple Energy Challenges—What They Are and What We Can Do About Them

---

Howard Geller

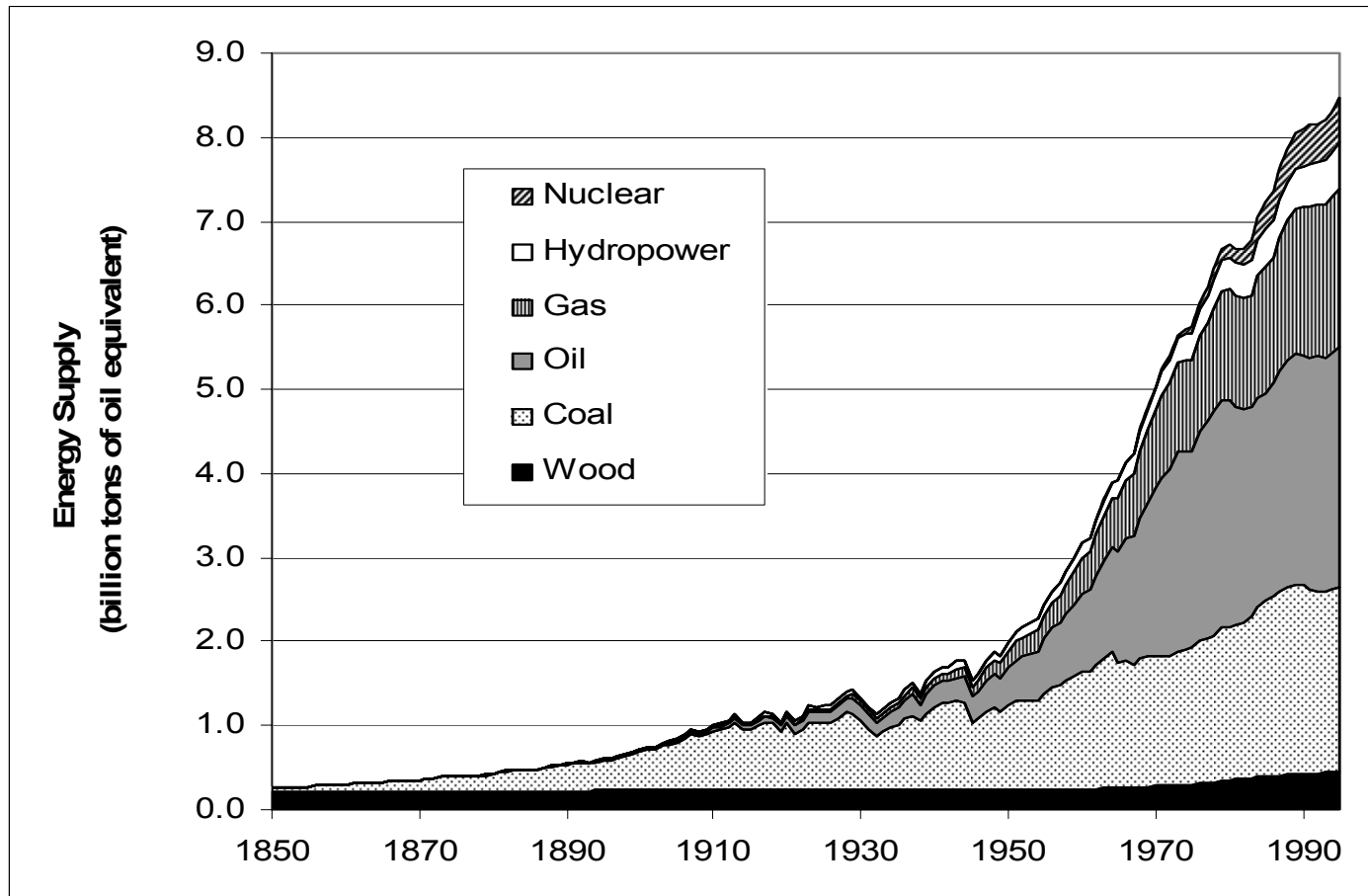


University of Colorado

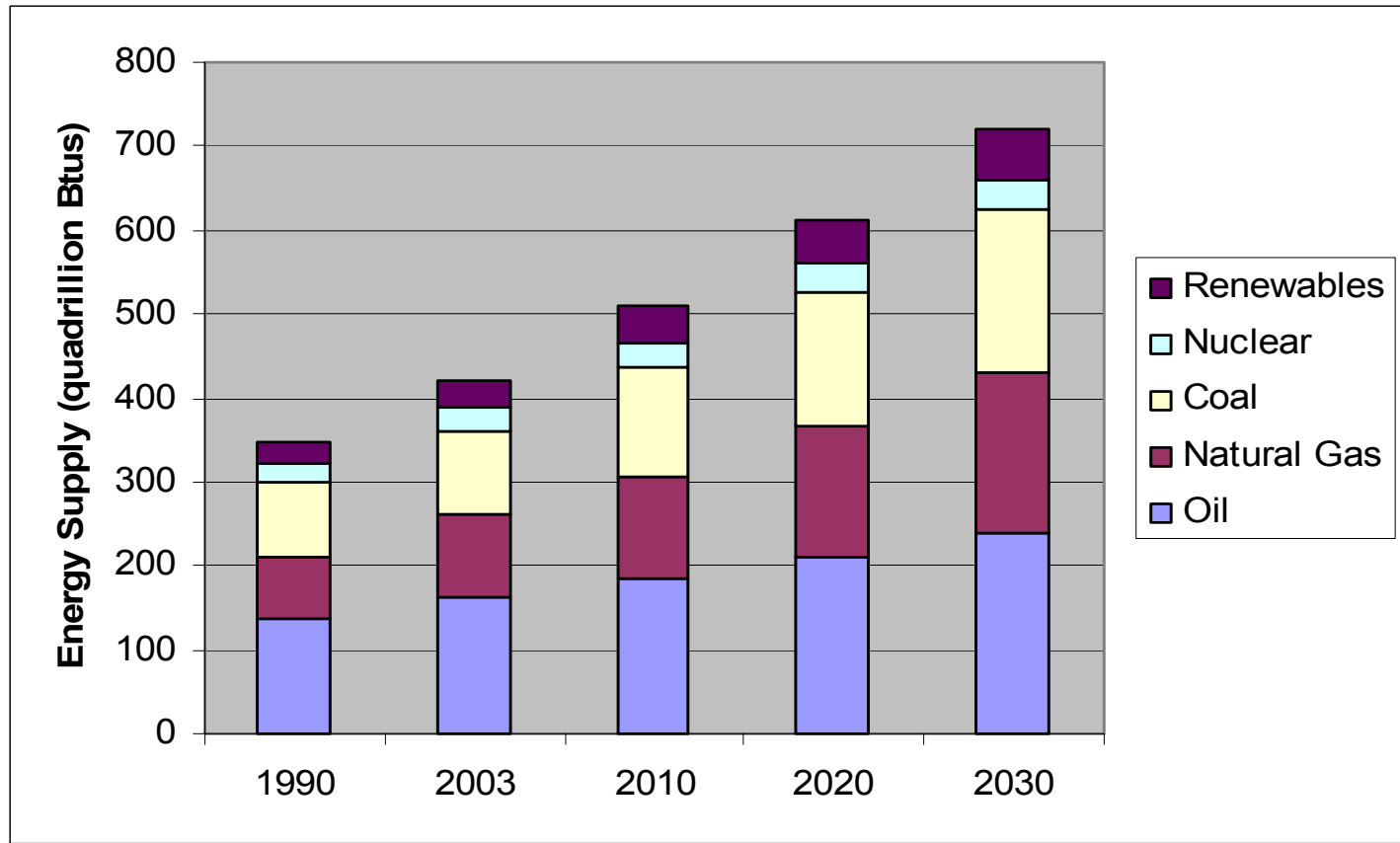
Boulder, CO

October 31, 2006

# World Energy Supply Since 1850



# Projected World Energy Supply Through 2030



Source: 2006 International Energy Outlook, U.S. EIA

# What's Wrong with a Business-as-Usual Energy Future?

---

- ❑ Accelerates global warming, with a variety of adverse impacts
- ❑ Rapidly depletes conventional oil resources
- ❑ Increases security risks due to oil import dependence and competition for limited oil supplies
- ❑ Raises the cost of providing energy services
- ❑ Harms public health due to local and regional air pollution
- ❑ Downplays global equity and enhanced standards of living among the poor

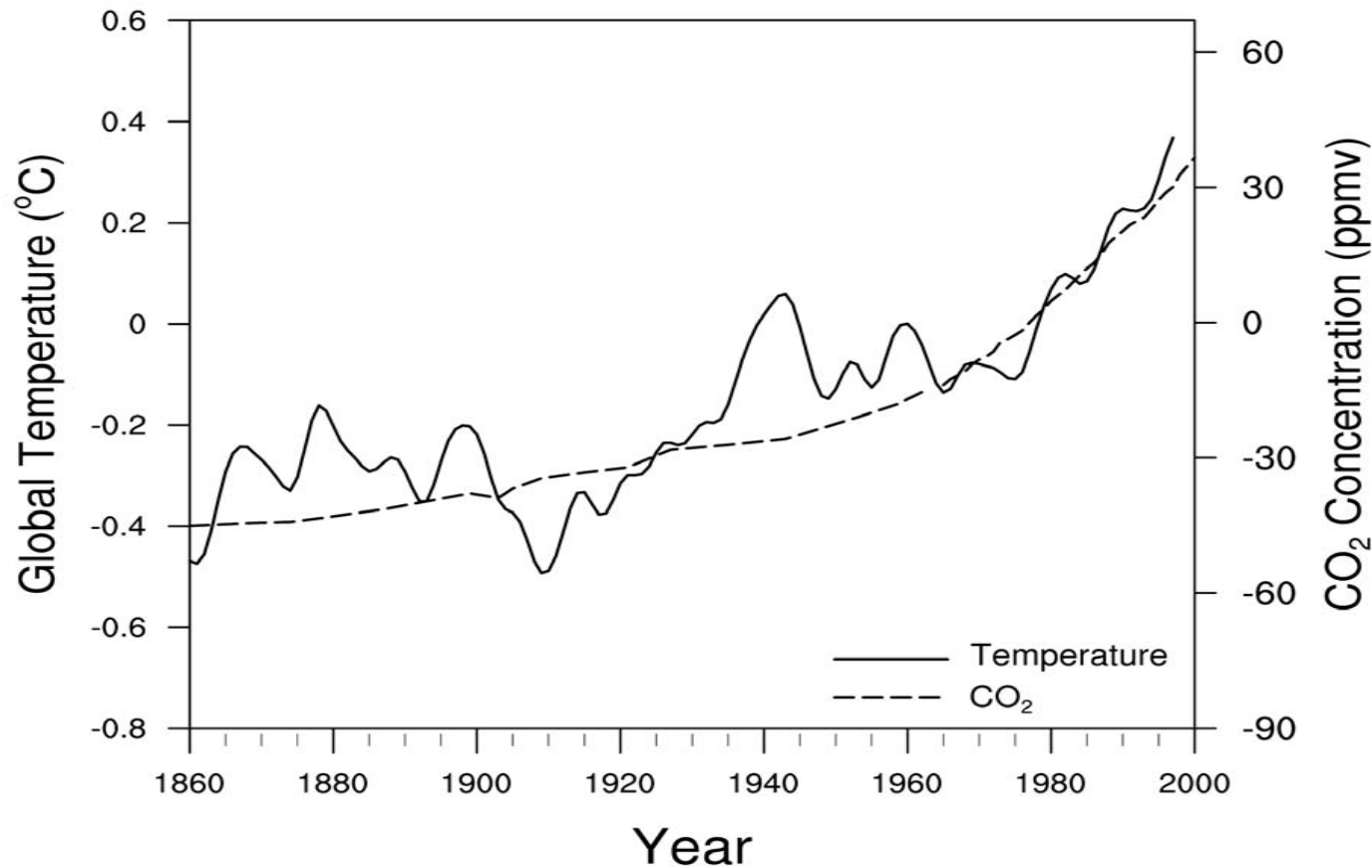
# Evidence of Global Warming Is Mounting

---

- ❑ Greenhouse gases building up rapidly in the atmosphere; CO<sub>2</sub> ~35% higher and CH<sub>4</sub> ~170% higher than pre-industrial levels
- ❑ Average temperature increase of 0.6°C in past century; temperature rise accelerating
- ❑ More extreme weather events—drought, flooding, hurricanes
- ❑ Arctic, Antarctic and Greenland ice melt
- ❑ Ocean acidification
- ❑ Less snow and changes in rainfall in the West—impacts on agriculture, water supply, wildfires, etc.

# Trends in Global Mean Temperature and Atmospheric CO<sub>2</sub> Concentration

---



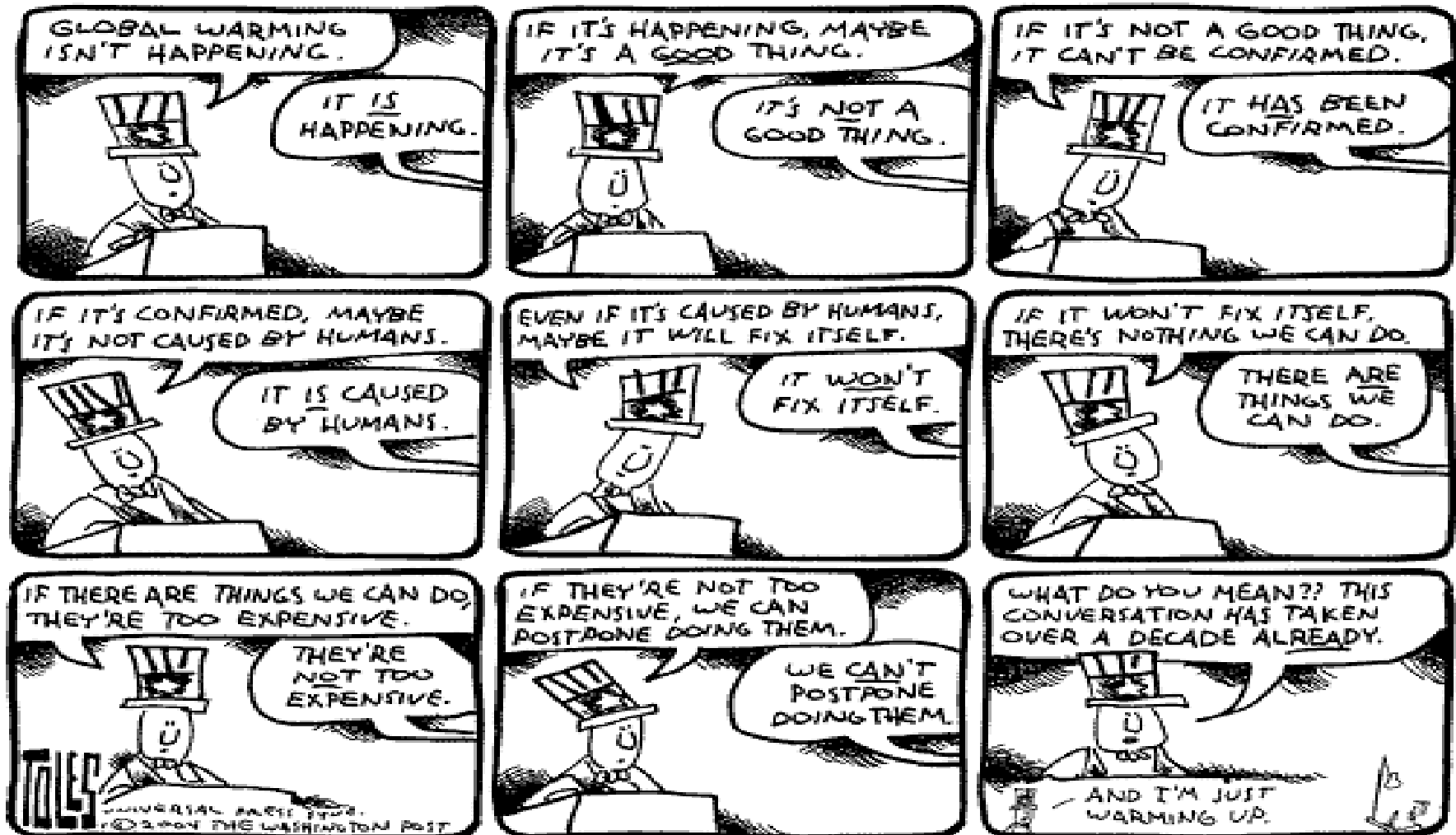
Note: change from average during 1961-90

# Business-As-Usual Energy Future Continues Rapid Global Warming

---

- ❑ 3°C or more temperature rise by end of century
- ❑ Increases frequency and magnitude of extreme weather events
- ❑ Raises sea level 6 meters or more
- ❑ Spreads infectious diseases
- ❑ Causes massive species loss
- ❑ Leads to positive feedbacks from more forest fires, release of CH<sub>4</sub> from frozen tundra, decrease of surface reflectivity, etc.
- ❑ Risks climate catastrophe such as shutdown of the Gulf Stream

# The Global Warming Debate Advances...





# Business-As-Usual Energy Future Leads To Oil Crisis

---

- ❑ World oil demand grows around 1.5-2.0% per year, but world oil production peaks within next 20 years, possibly much sooner
- ❑ Oil price could skyrocket if oil demand outstrips supply and alternative fuels are not available in large quantities
- ❑ Potential liquid fuel deficit
- ❑ Increasing global tension and conflict over limited oil supplies

# Peak Oil Production in the U.S.

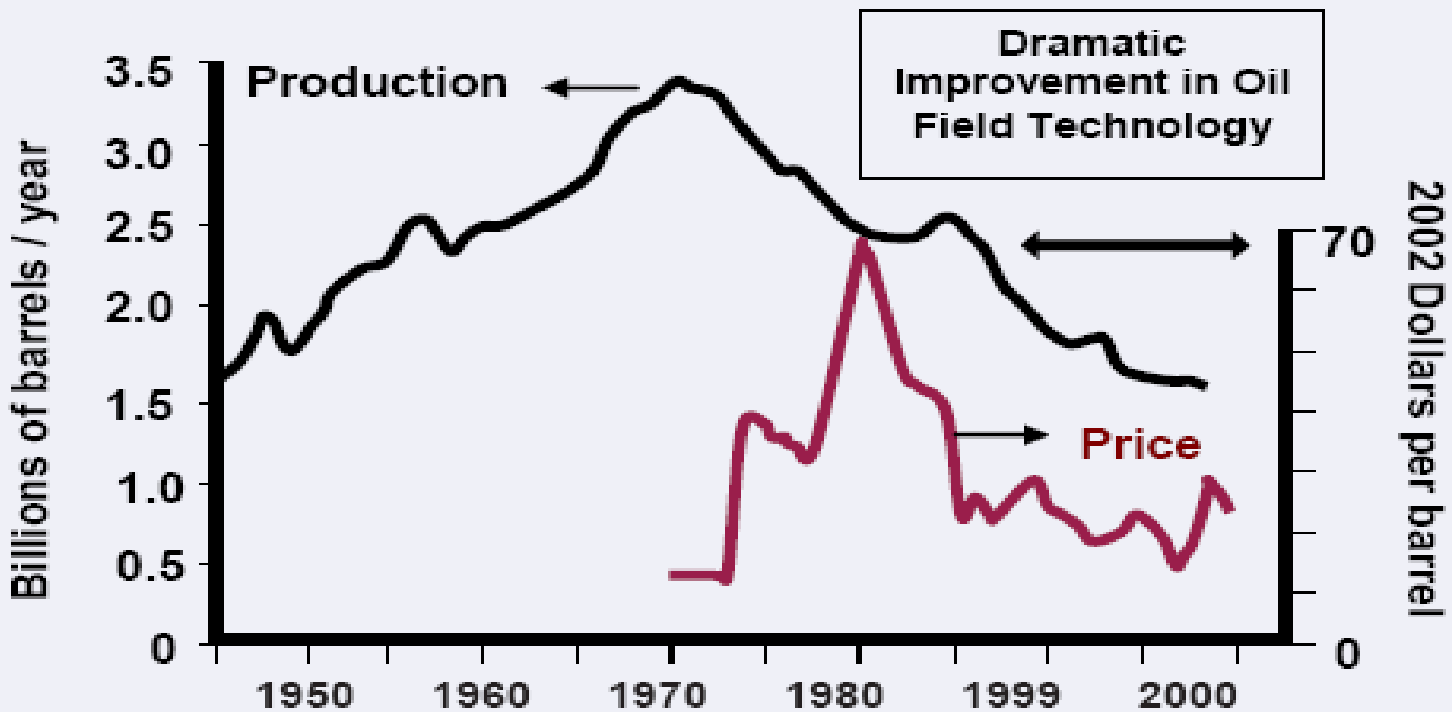


Figure 2. The decline of U.S. Lower 48 oil production was not reversed by large changes in oil prices or the dramatic improvement in oil field technologies.

Source: Robert Hirsch, Atlantic Council Bulletin, Oct. 2005.

# Roots of Our World Oil Dilemma

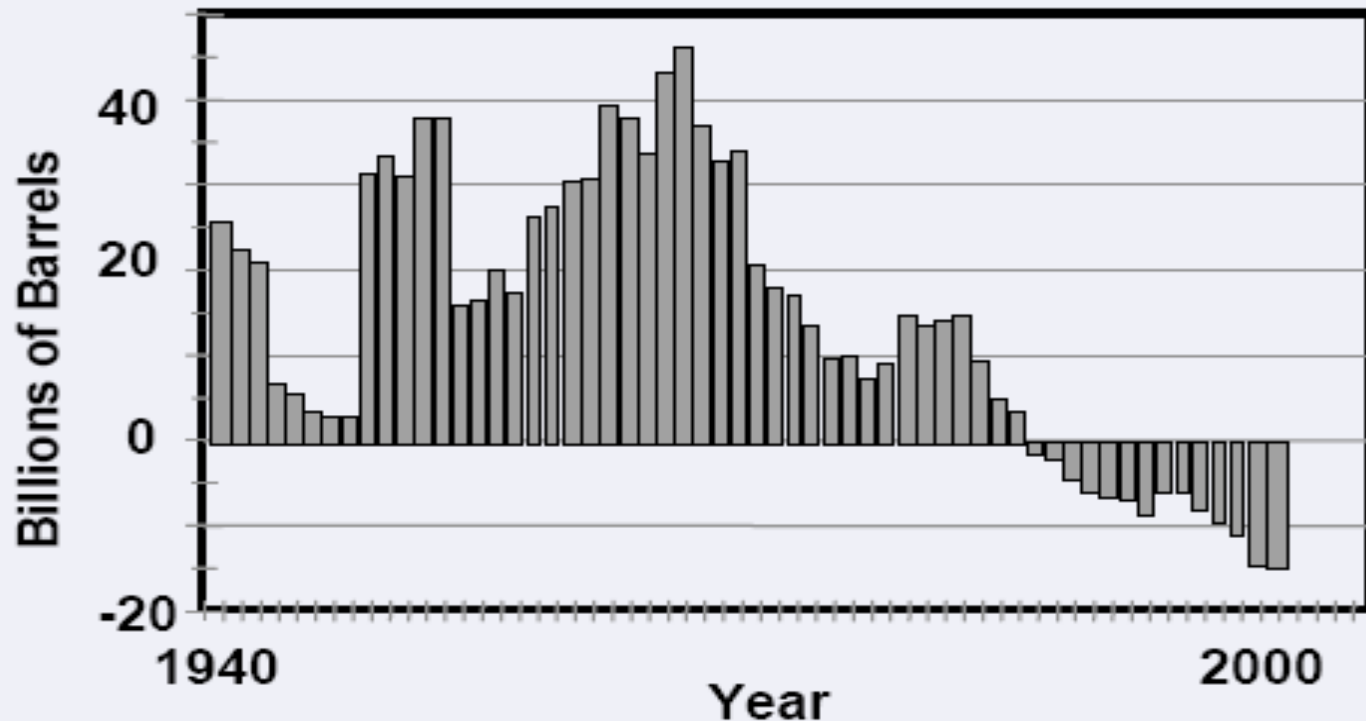


Figure 1. The net difference between annual world oil reserves additions and annual oil consumption has been declining for decades.

Source: Robert Hirsch, Atlantic Council Bulletin, Oct. 2005.

# Predictions of Peaking of World Oil Production

---

- 2007-2009: Matthew Simmons, investment banker
- Before 2009: Ken Deffeyes, retired oil company geologist
- Before 2010: David Goodstein, Cal Tech physicist
- Around 2010: Colin Campbell, oil geologist
- 2016: U.S. EIA nominal case
- After 2020: Dan Yergin, CERA

# Business-As-Usual Energy Future Presents National Security Risks

---

- ❑ Maintaining a military presence in the Middle East and at times fighting wars to protect oil supplies
- ❑ Economic vulnerability to oil price spikes or supply disruptions
- ❑ Support for undemocratic, repressive governments in the Middle East that keep oil flowing contributes to poverty, frustration and terrorism
- ❑ Vulnerable energy supply infrastructure

# Tom Toles on the Oil Import - Global Warming - National Security Nexus



12-2-02

# Business-As-Usual Energy Future Raises the Cost of Energy Services

---

- ❑ Building power plants, oil and gas pipelines, etc. is very capital-intensive
- ❑ Investment in energy infrastructure of \$500 billion to \$1 trillion per year worldwide in a BAU energy future
- ❑ Very costly for developing and former communist countries in particular
- ❑ High energy growth places upward pressure on oil and natural gas prices
- ❑ Energy inefficiency increases costs

# Business-As-Usual Energy Future Harms Environment & Public Health

---

- ❑ Nearly half of U.S. population lives in counties that do not meet air quality standards, in spite of declining air pollutant emissions
- ❑ More urban smog, hazardous particulates, and mercury emissions than otherwise would occur
- ❑ Increasing fossil fuel use also damages forests, crops, and vulnerable ecosystems
- ❑ Air pollution especially harmful in developing countries like China and India



# Responding to Our Multiple Energy Challenges—The Bush Strategy



# And Dick Cheney Weighs in...

"Conservation may be a sign of personal virtue, but it is not a sufficient basis for a sound, comprehensive energy policy."

--Dick Cheney  
April 30, 2001

MAYBE...UH...PEOPLE  
COULD DRIVE LESS?  
ER...THAT WOULD BE  
OK, WOULDNT IT??



CARSON  
AMERICAN OVERSIGHT SOCIETY  
UNIVERSITY OF TEXAS AT AUSTIN

# A More Comprehensive and Prudent Energy Strategy

---

- ❑ Dramatically reduce CO<sub>2</sub> and other GHG emissions in order to keep atmospheric CO<sub>2</sub> levels to below 450 ppmv
- ❑ Cut oil use steadily and substantially in conjunction with peak in world production
- ❑ Aggressively pursue cost-effective energy efficiency improvements
- ❑ Rapidly develop and implement renewable sources of fuel and electricity
- ❑ U.S. leads by reducing CO<sub>2</sub> emissions and oil use more than most other nations

# Two Scenarios for Future U.S. Energy Supply/demand: BAU and Alternative

---

- **Business-as-usual:** future resembles the past with growing consumption of oil, coal, and natural gas; limited energy efficiency improvement and renewable energy adoption; no behavior change; and piecemeal responses to the challenges
- **Alternative:** much greater pursuit of energy efficiency and renewable energy sources; steady decline in oil and coal reliance; modest behavior change; and a serious effort to address the challenges

# Business-As-Usual Scenario for U.S.

---

- ❑ 0.8% annual population growth and 3% annual GDP growth 2005-2050
- ❑ Energy intensity (E/GDP) declines 2%/yr but primary energy use still grows 1%/yr
- ❑ Renewable energy increases only 2%/yr
- ❑ Average vehicle fuel efficiency improves only moderately and vehicle fuel use increases 1.4%/yr
- ❑ Nuclear energy supply grows slightly
- ❑ Based on Annual Energy Outlook 2006 Reference Case, U.S. EIA

# Consequences of the Business-As-Usual U.S. Scenario

---

- ❑ Consumption of oil, coal and natural gas all increase 50-60% by 2050
- ❑ U.S. CO<sub>2</sub> emissions 55% higher in 2050 compared to 2005
- ❑ U.S. consumes 32 MBD of oil by 2050, with ~85% of this imported
- ❑ Very high economic and environmental costs, if it is even feasible
- ❑ Where will the oil come from? Can we continue to ignore climate change?

# Alternative U.S. Scenario

---

- ❑ 0.8% annual population growth and 2.7% annual GDP growth 2005-2050
- ❑ Moderate shift in behavior—slightly smaller houses and vehicles, less driving, etc.
- ❑ Double energy efficiency in 2050 relative to BAU scenario; energy intensity declines 3.4%/yr (higher than economic growth)
- ❑ Renewable energy use increases 4%/yr rather than 2%/yr in BAU scenario
- ❑ Nuclear power plants are shutdown at end of useful life and are not replaced

# Technologies for Doubling Energy Efficiency in the Residential Sector

---

- ❑ Widespread use of CFLs
- ❑ Building envelope and HVAC system improvements
- ❑ Resource-efficient clothes washers, high efficiency refrigerators, other appliances
- ❑ Heat pump and condensing natural gas water heaters
- ❑ More efficient electronic devices with reduced standby power



# Renewable Energy Development in the Alternative Scenario, 2005-2050

---

- 5,000 MW of wind power capacity added annually including off-shore wind farms
- 1,500 MW of solar power capacity added annually, combination of PV and concentrating solar power
- 1,000 MW of geothermal and biopower added annually with high capacity factor
- Hydro power remains level

# Transportation Sector Assumptions in the Alternative Scenario

---

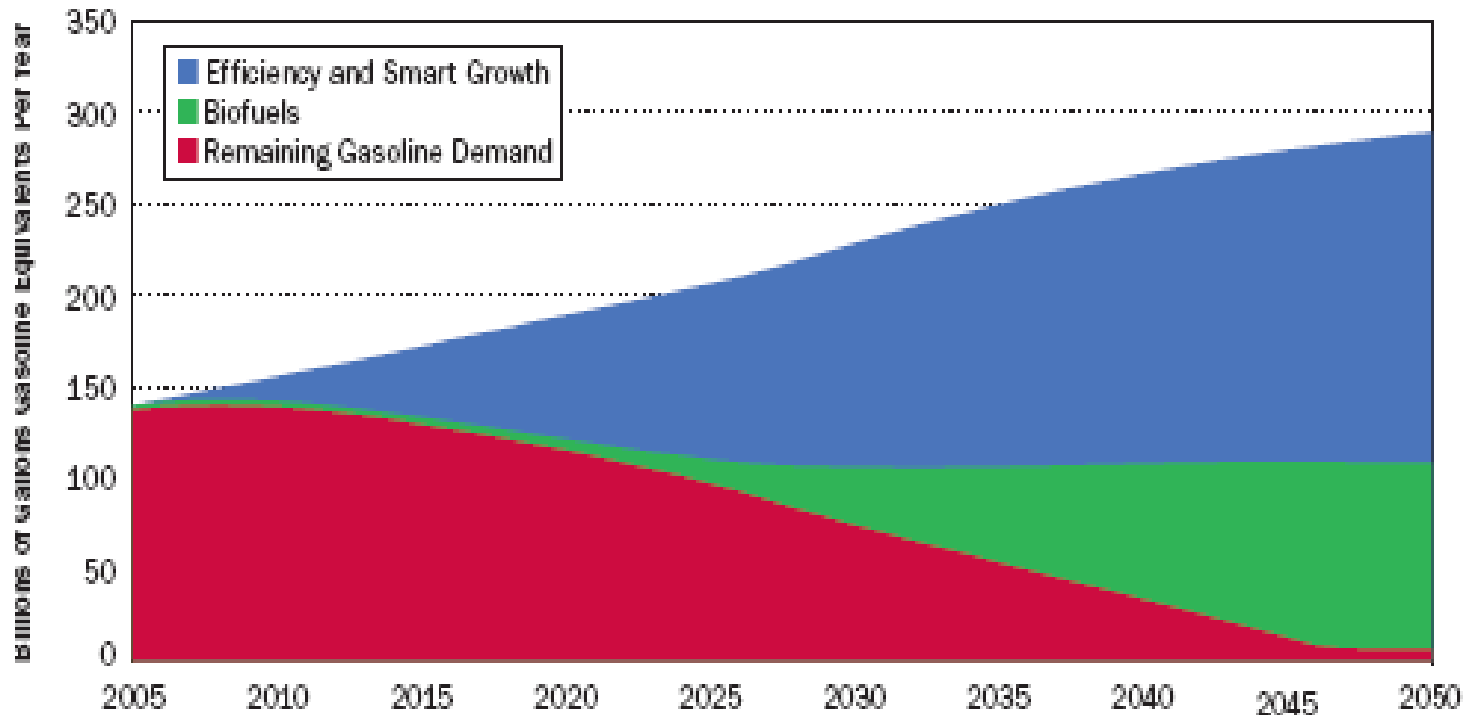
- ❑ Passenger vehicles average 42 MPG on-road by 2050 compared to 19 MPG today
- ❑ Heavy-duty vehicles average 8.7 MPG on-road by 2050 compared to 5.6 MPG today
- ❑ 10% less driving in 2050 compared to BAU scenario
- ❑ Energy crops such as switchgrass and cellulosic-based ethanol aggressively developed and deployed, providing 8 MBD of oil-equivalent by 2050

Source: **Growing Energy**, Natural Resources Defense Council, Dec. 2004

# Cutting Oil Demand with Vehicle Fuel Efficiency Gains and Alternative Fuels

---

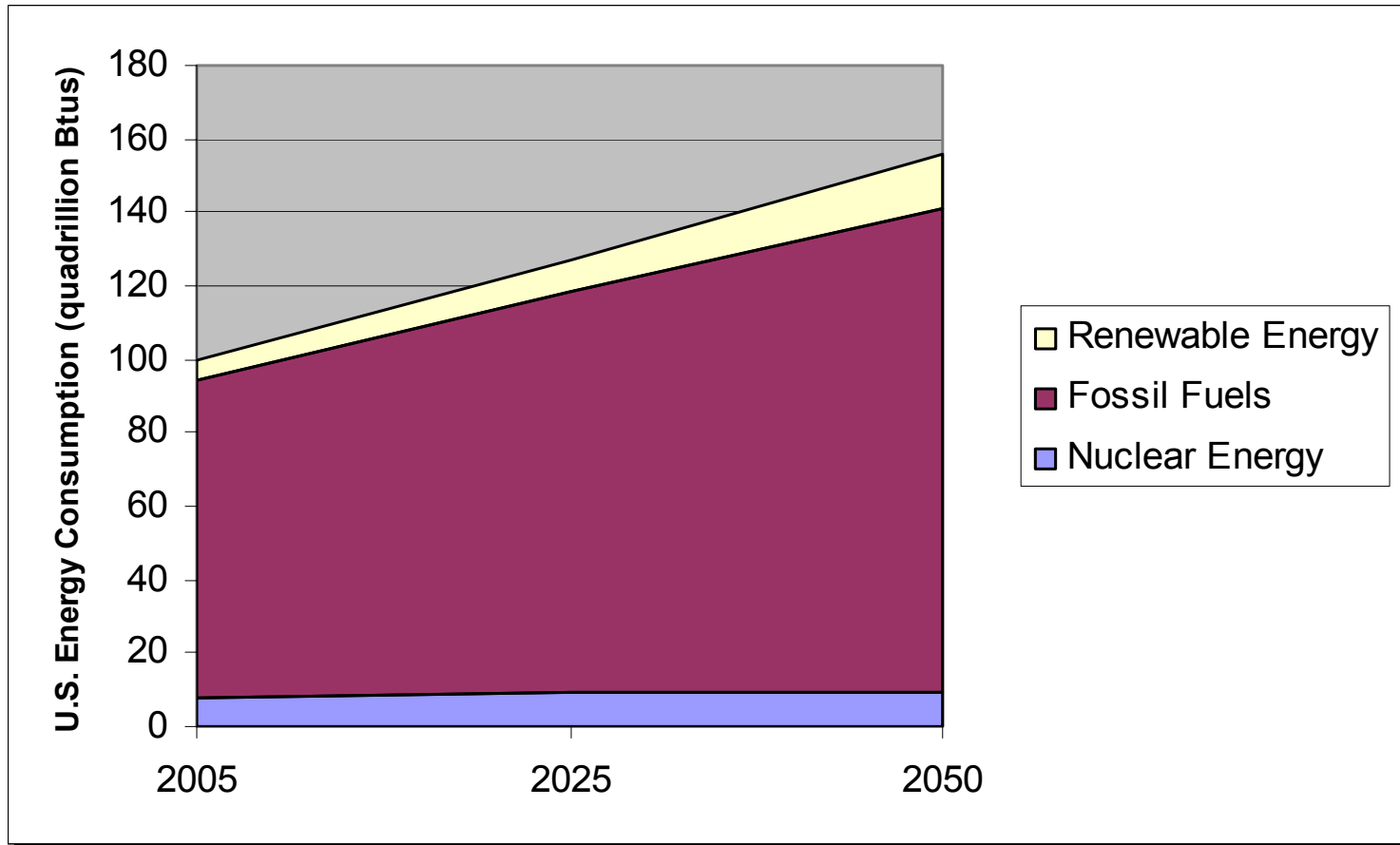
Reduced Gasoline Demand through Biofuels, Efficiency, and Smart Growth



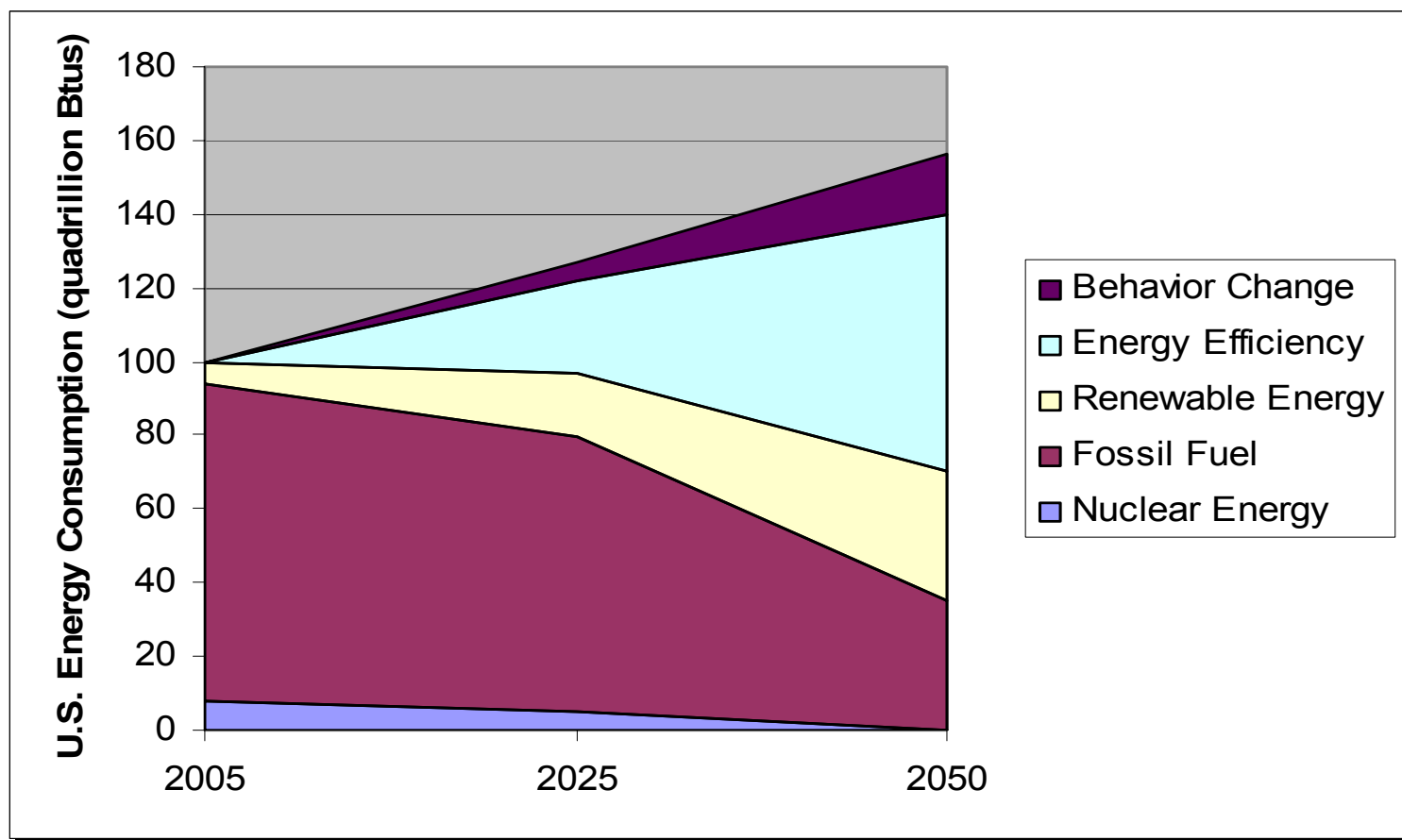
Source: **Growing Energy**, Natural Resources Defense Council, Dec. 2004

# Business-As-Usual Scenario

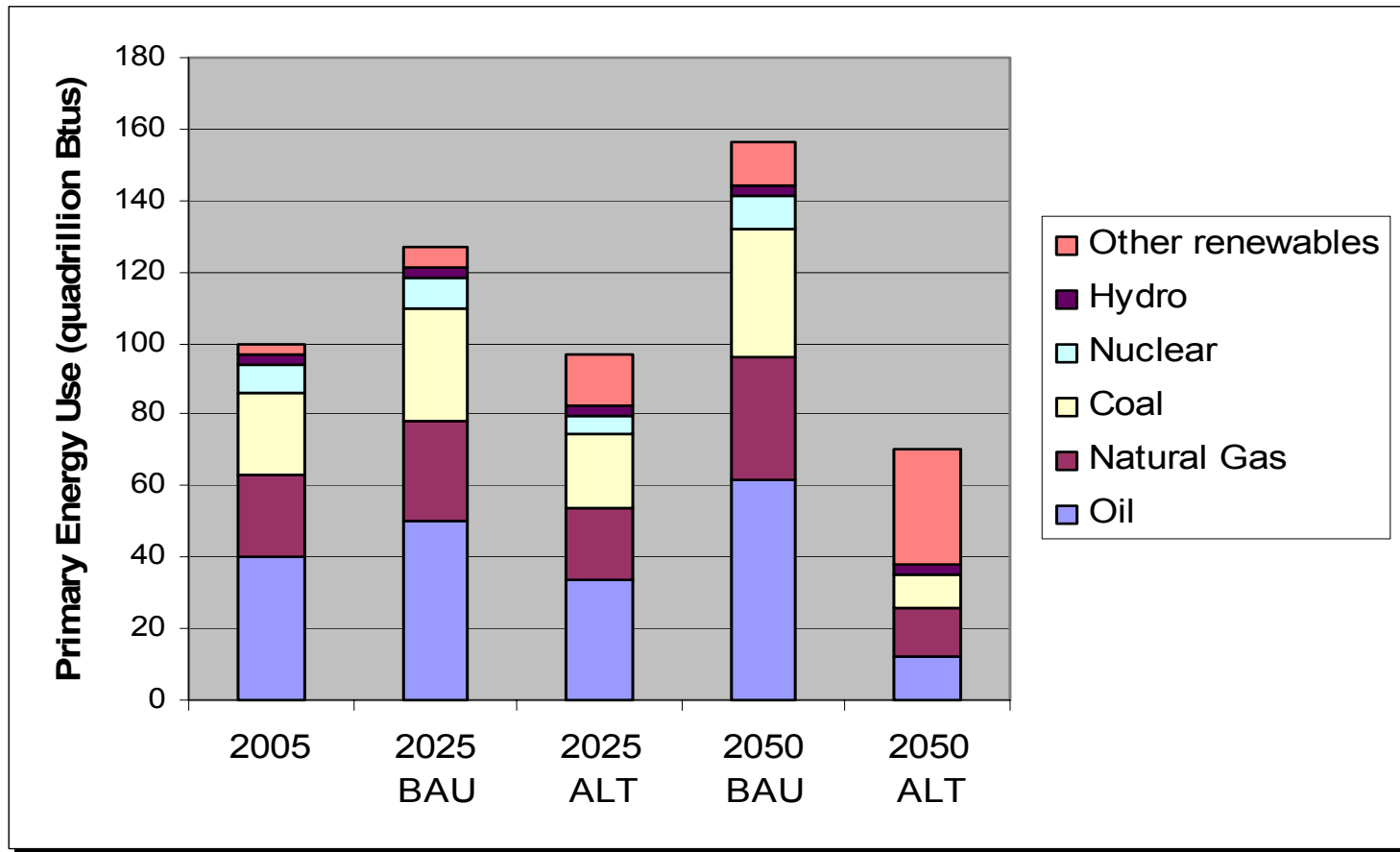
---



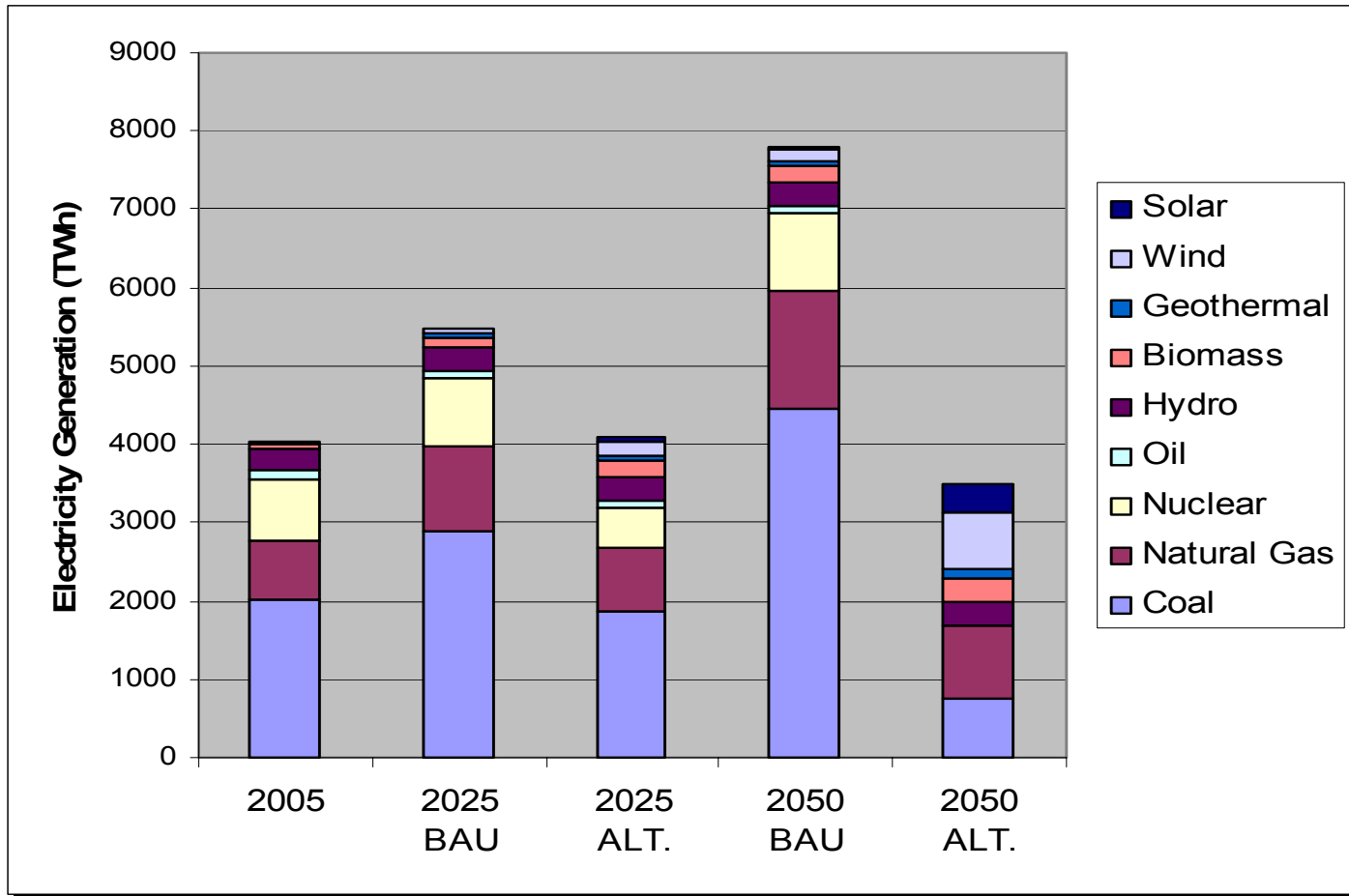
# Alternative Scenario



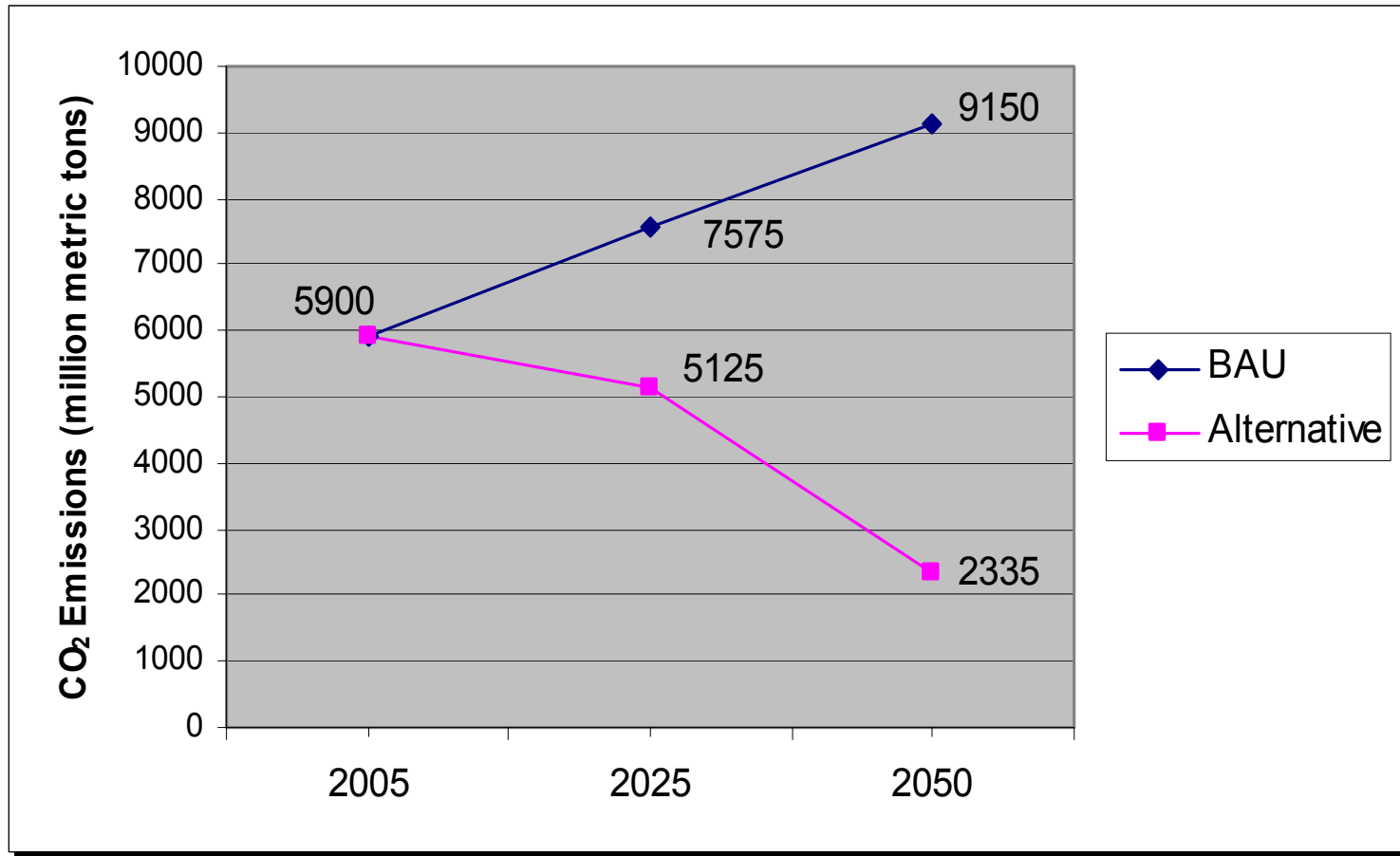
# Comparison of BAU and Alternative Scenarios-Primary Energy Supply



# Comparison of BAU and Alternative Scenarios—Electricity Supply



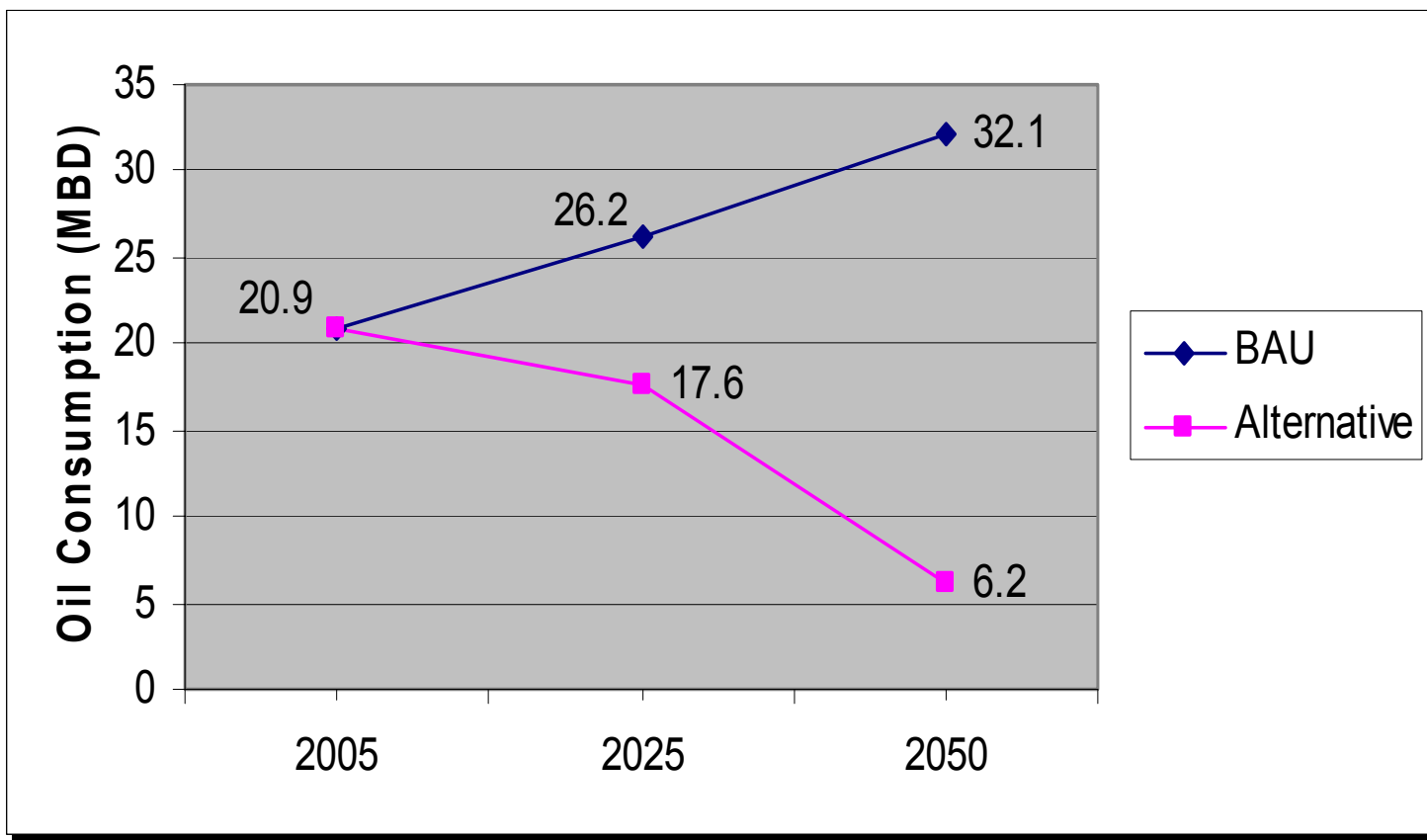
# Comparison of BAU and Alternative Scenarios—CO<sub>2</sub> Emissions





# Comparison of BAU and Alternative Scenarios—Oil Consumption

---



# Alternative Scenario--Summary

---

- Primary energy use in 2050: 55% less than BAU scenario and 30% less than 2005
- Renewable sources provide ~1/2 of electricity supply in 2050
- Biofuels provide ~2/3s of transport fuel in 2050
- Oil use falls 70% during 2005-2050
- Coal use falls 60% during 2005-2050
- Natural gas use falls 32% during 2005-2050

# Policies for Achieving the Alternative Scenario

---

- Appliance, vehicle, and building efficiency standards
- Renewable electricity and fuels standards
- Financial incentives for going beyond the minimum standards
- Incentives for coal power plant retirement
- CO<sub>2</sub> emissions cap with trading allowed
- Vigorous RD&D on next generation energy efficiency and renewables technologies
- Adoption of best practice state and local policies at the national level

# Progress Towards the Alternative Scenario at the State and Local Level

---

- ❑ CA has made new commitments to energy efficiency, renewable energy, and GHG emissions reduction
- ❑ AZ has adopted aggressive GHG emissions reduction goals—50% cut from 2000 emissions level by 2040
- ❑ UT has adopted a 20% energy efficiency improvement goal by 2015 (yes Utah!)
- ❑ Utility sector CO<sub>2</sub> cap and trade program in the Northeast (RGGI)
- ❑ Over 300 cities with 50+ million residents have committed to meeting Kyoto targets

# How Can We Foster Behavior and Lifestyle Change?

---

- ❑ Educational efforts, engage religious institutions, and use of role models
- ❑ Taxes and financial instruments—higher fuel or CO<sub>2</sub> taxes, taxes on driving, lower charges for public transportation, taxes on SUVs and “sport utility homes”, smart growth initiatives, etc.
- ❑ Changing values—encourage commitment to “conspicuous conservation” rather than conspicuous consumption

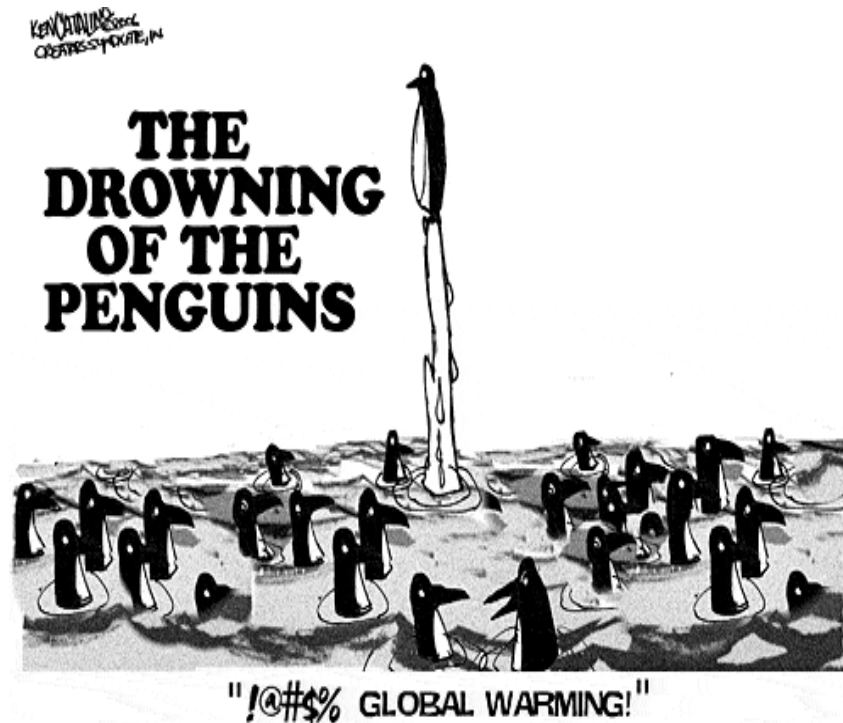
# What About Carbon Capture and Sequestration?

---

- ❑ Biological storage can be cost effective and provide other benefits, but depends on land/water availability and management; carbon storage can be reversed
- ❑ Ocean storage poses ecological risks and is of uncertain permanence
- ❑ Geological storage on large scale still unproven—but stepped up RD&D is warranted to determine if it will work, how much it will cost, what the technical issues are, and how acceptable it will be

# What Will the World Look Like in 2050? The Choice Is Ours!

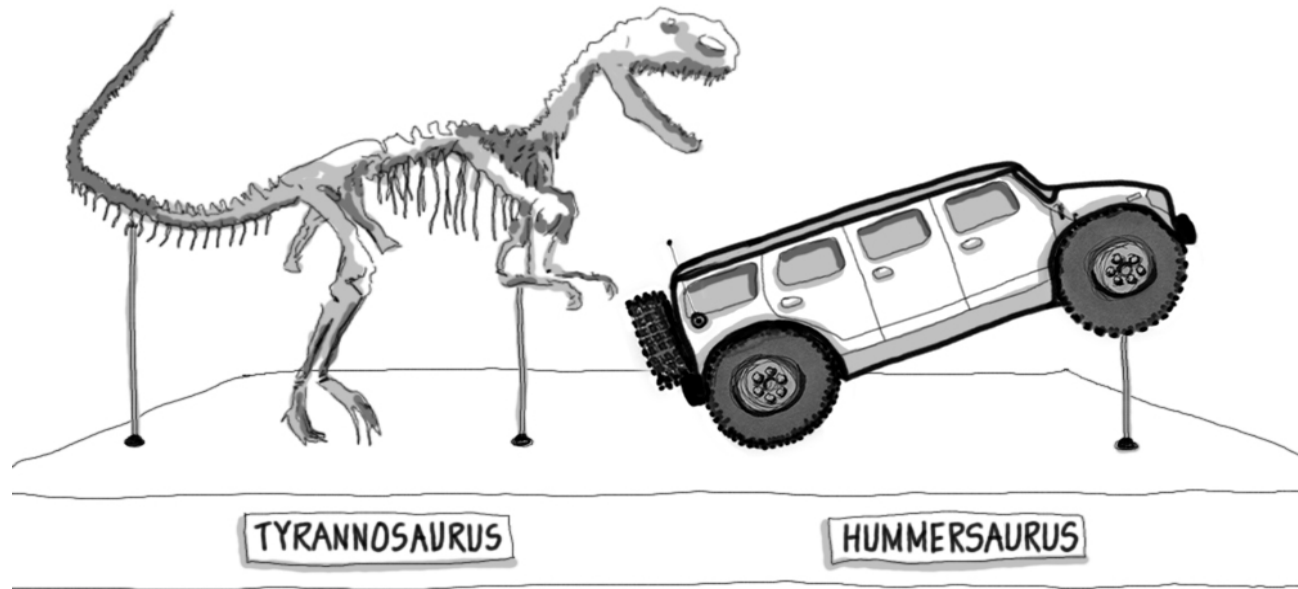
---



# And Last But Not Least...My Definition of an Off-Road Vehicle!

---

DINOSAUR EXHIBIT 2050



*lj*

For more information, contact [hgeller@swenergy.org](mailto:hgeller@swenergy.org)