Building a New Energy Industry in Northeast Ohio

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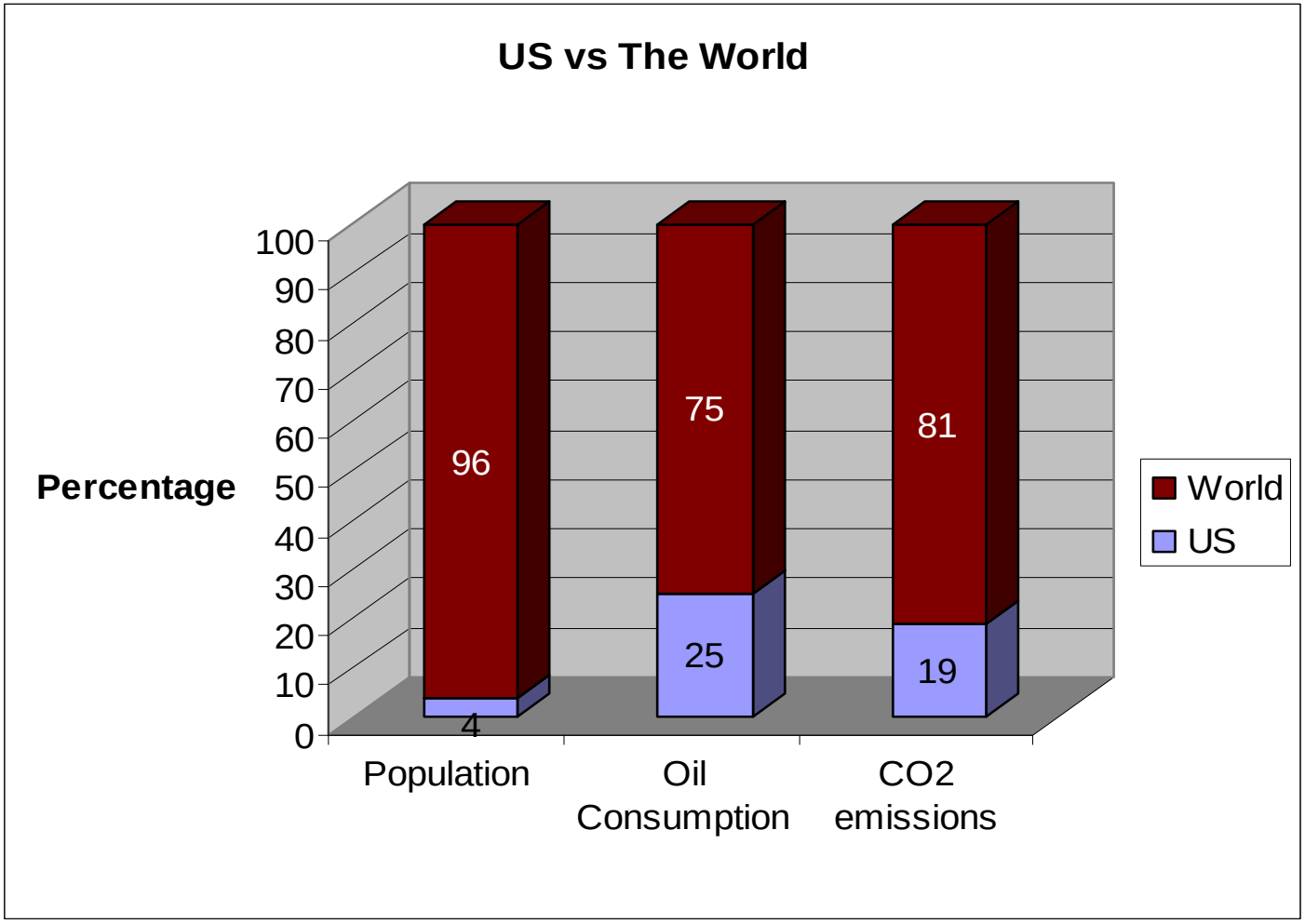
We Take Energy For Granted

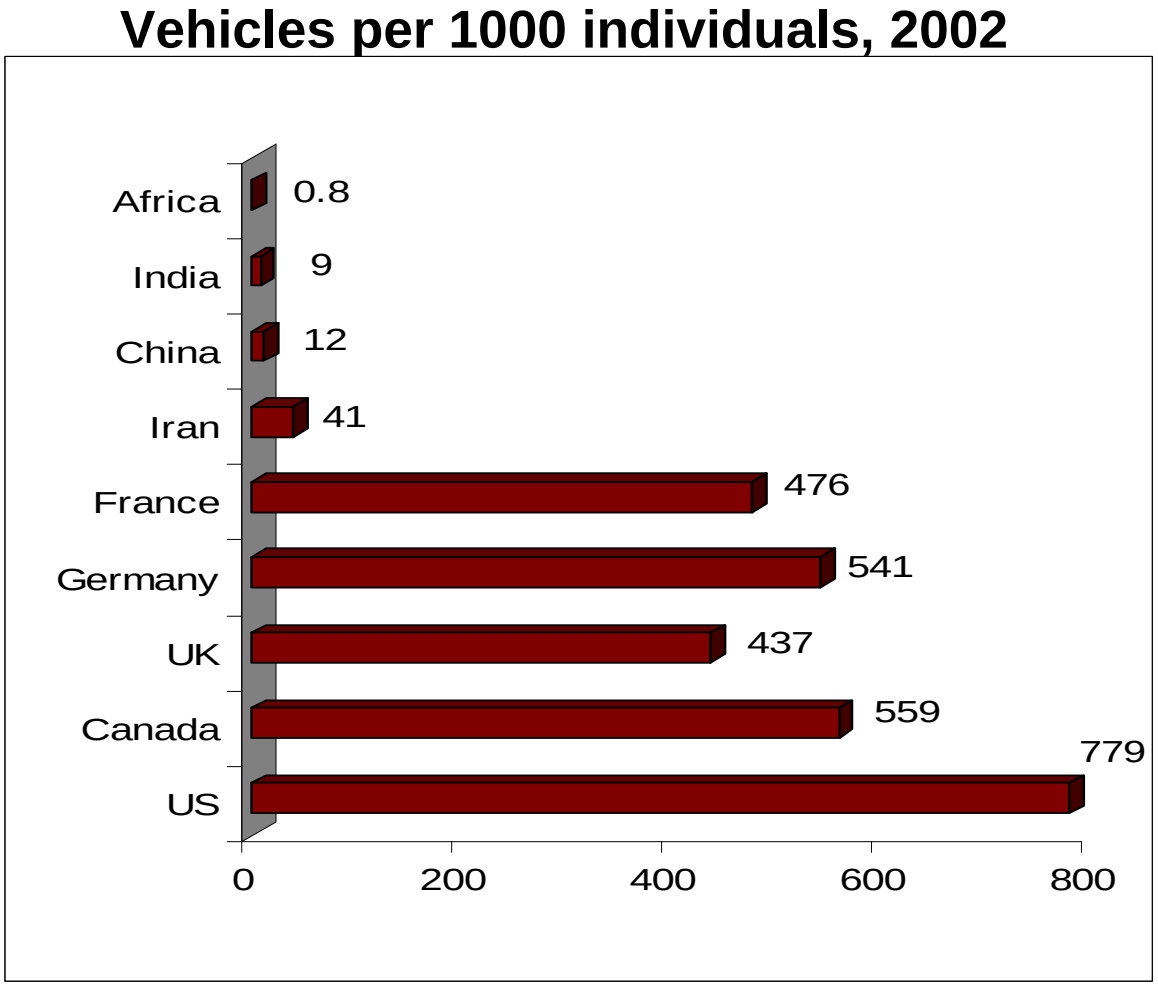
- **Supplying the American energy diet by human power would require 58 slaves working hard 24/7/365 for each citizen**
- **At a wage of $5.00/hour, the human energy equivalent of a barrel of oil would cost $45,000**
- **Each second, the world consumes 1000 barrels of oil**
- **Try living without electricity or gasoline for a week!**

The Energy Culprit: U.S.



Based on data from: NationMaster Oil Statistics, US Census Bureau and Earth trends

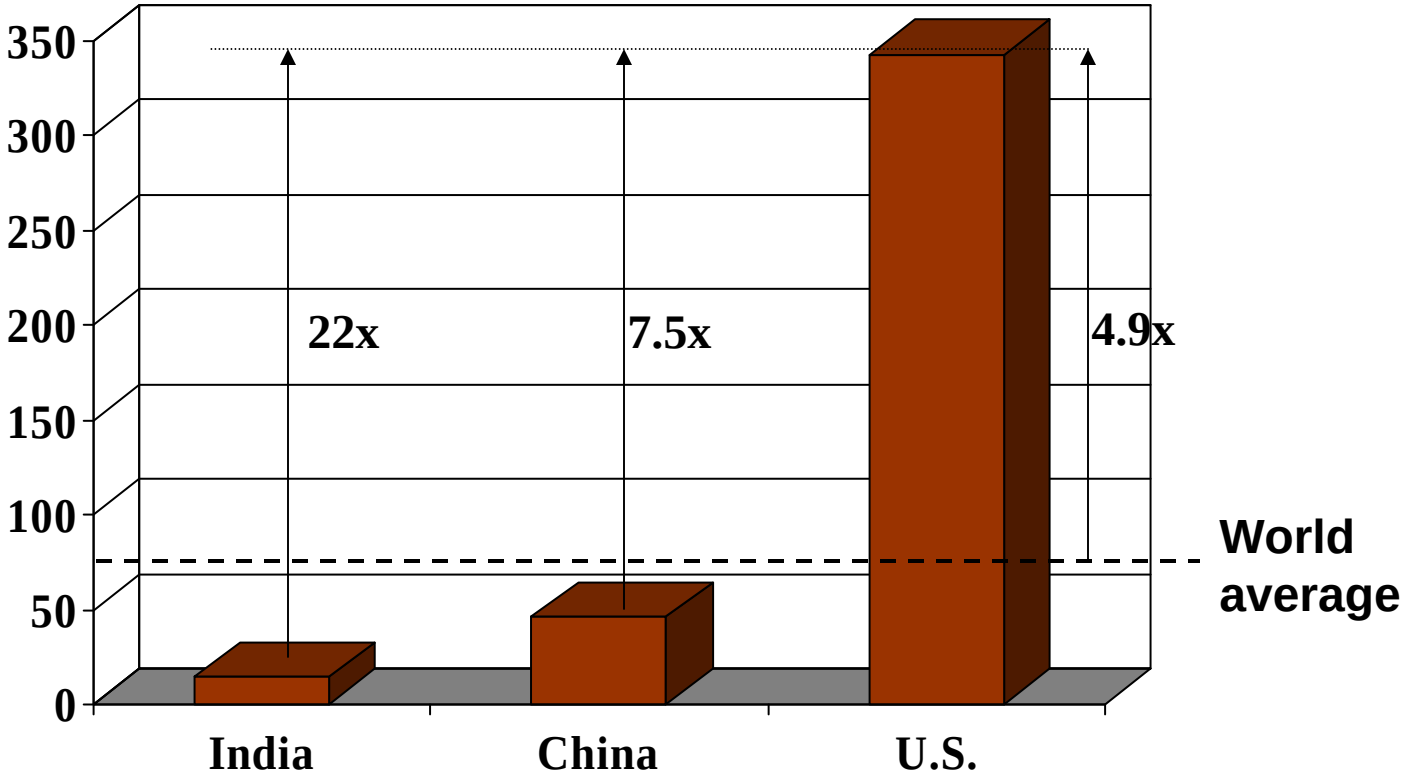
Auto Ownership Rates



Source: UNECE, Earth Trends

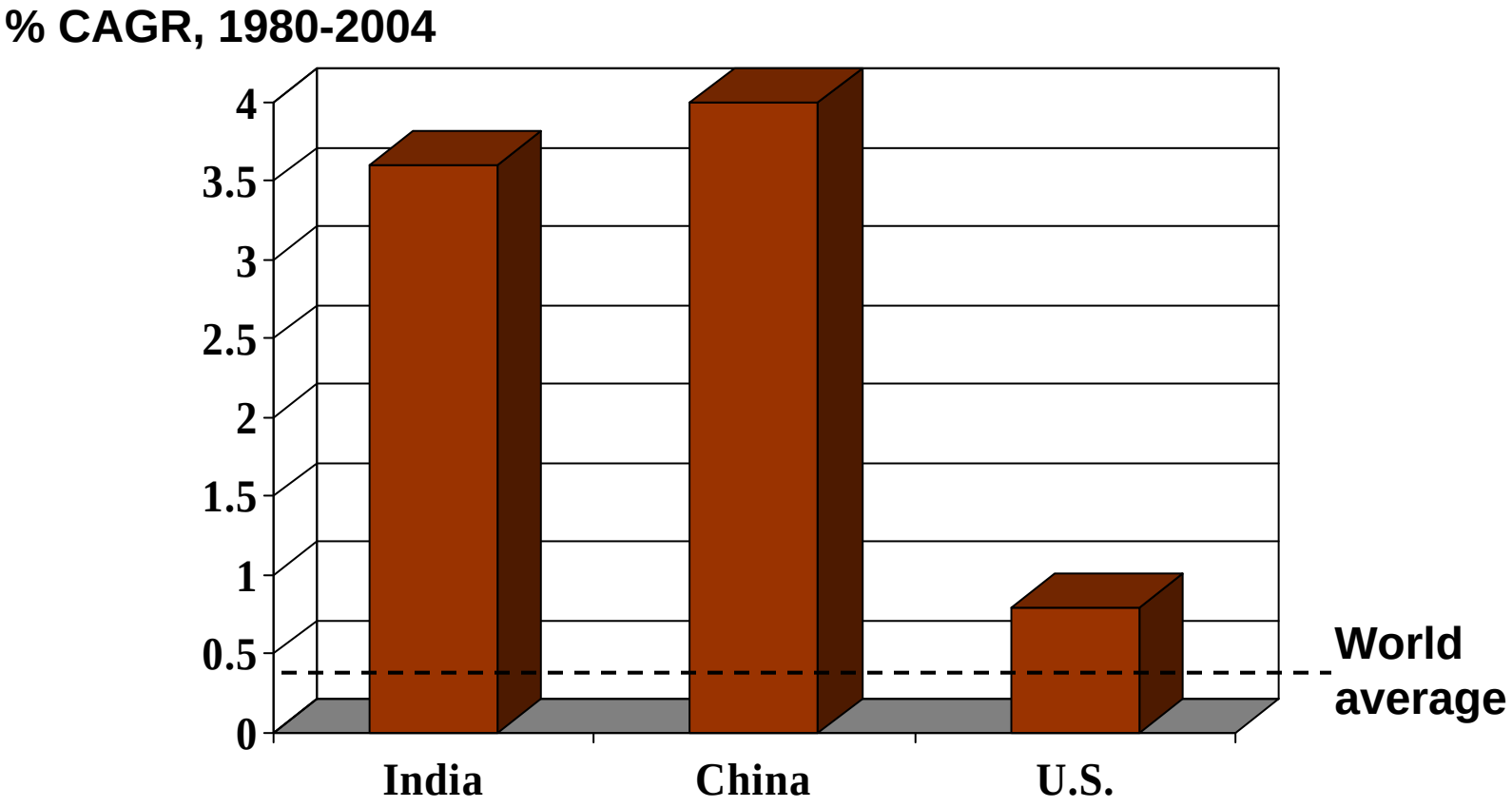
Energy Use Per Capita

million Btu, 2004



Source: International Energy Annual, Energy Information Administration

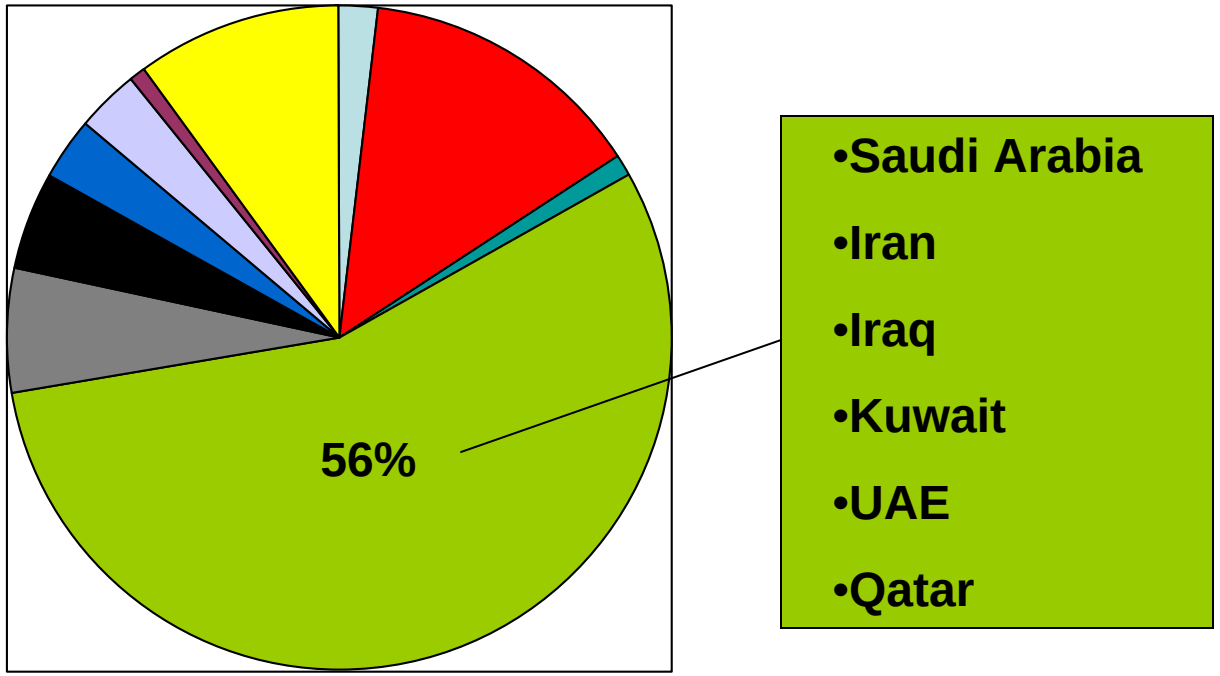
Energy Growth Rates



Source: International Energy Annual, Energy Information Administration

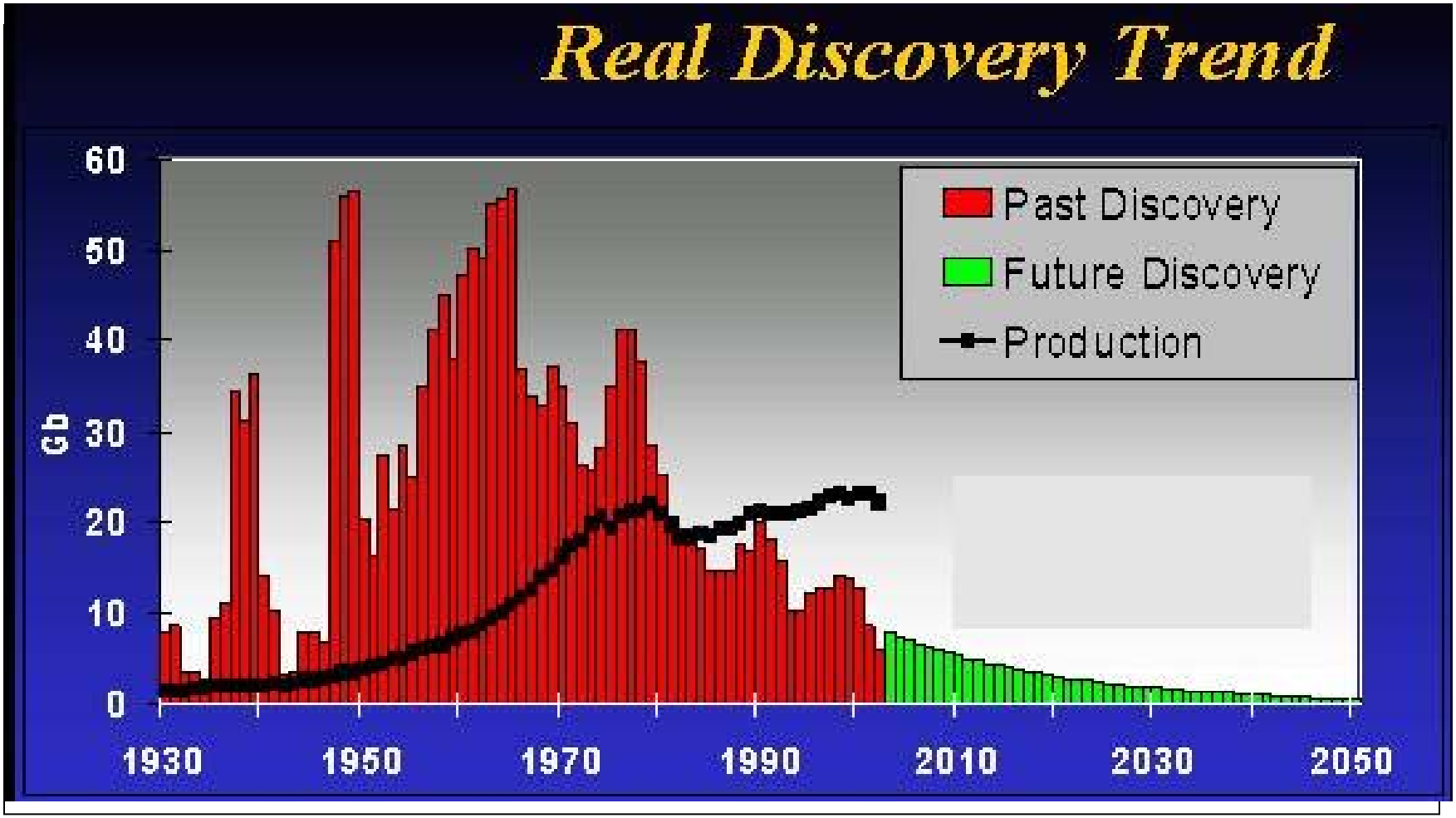
Most Remaining Oil in Middle East

100% = 1292.6 billion barrels



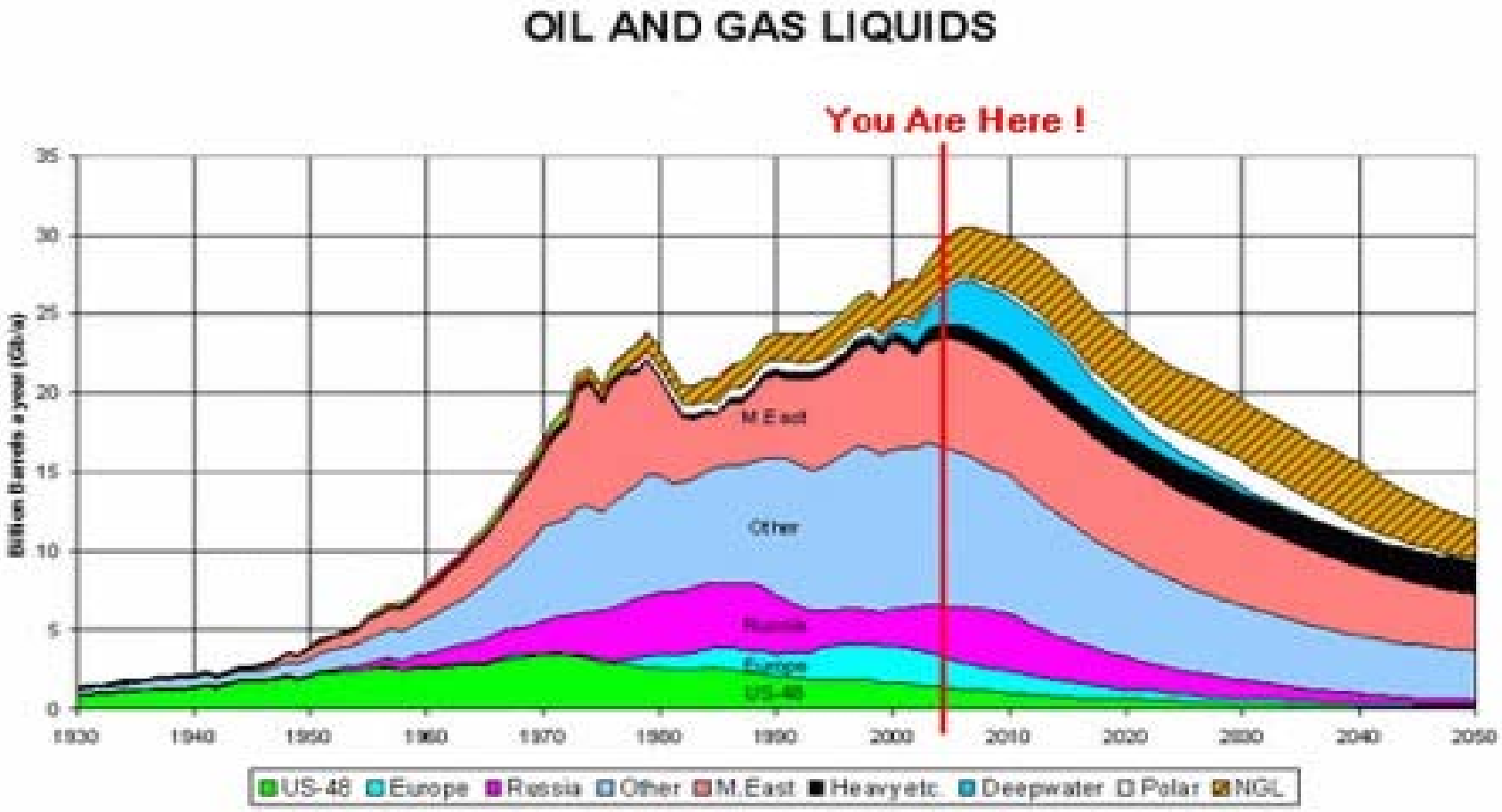
Source: Oil & Gas Journal, Vol. 102, No. 47 (Dec. 10, 2004), from U.S. EIA

Declining Global Oil Discoveries



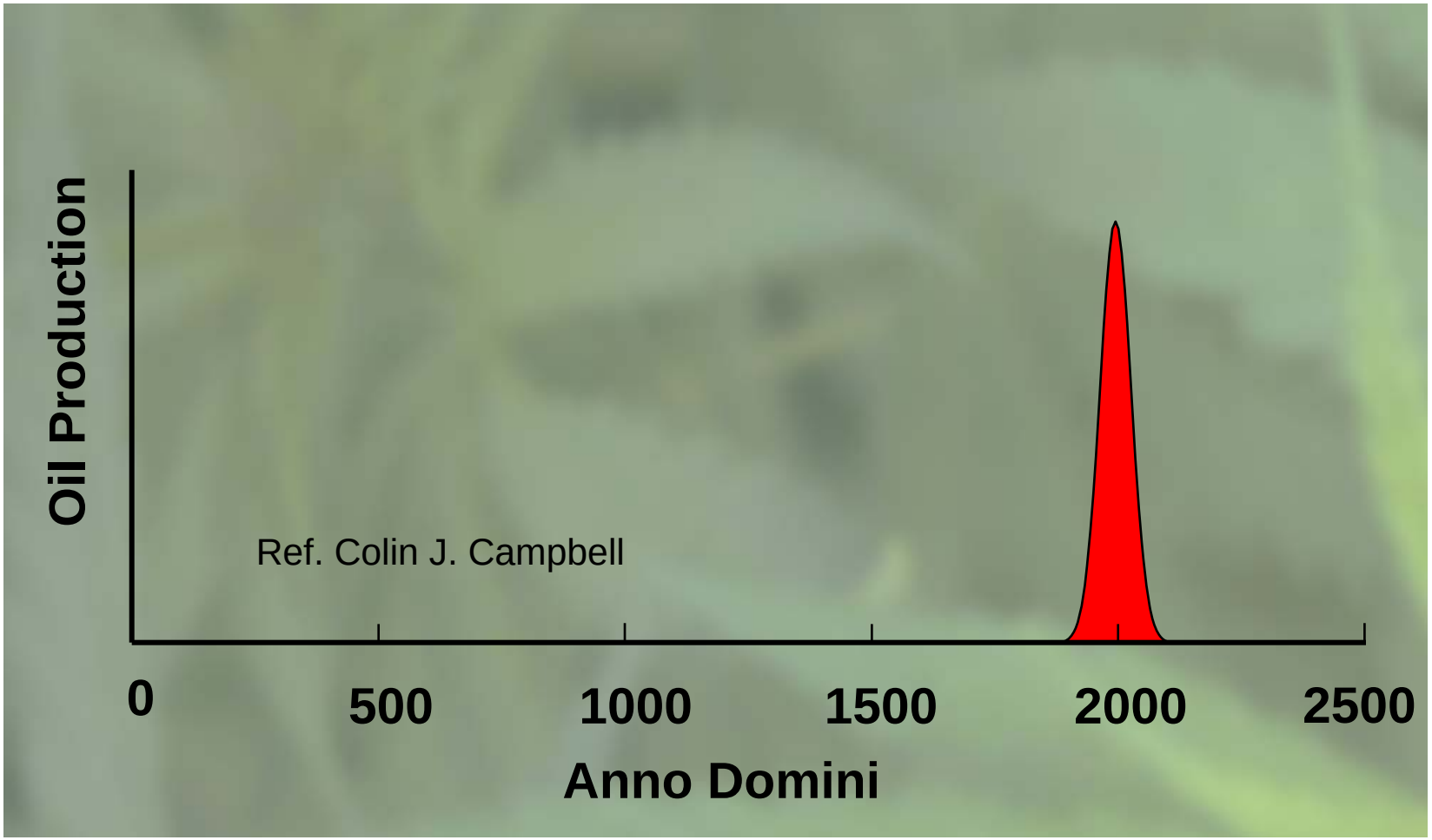
Source: Durango Bill Energy Analysis

Oil Production Peaking?



Source: www.romaenergia.org

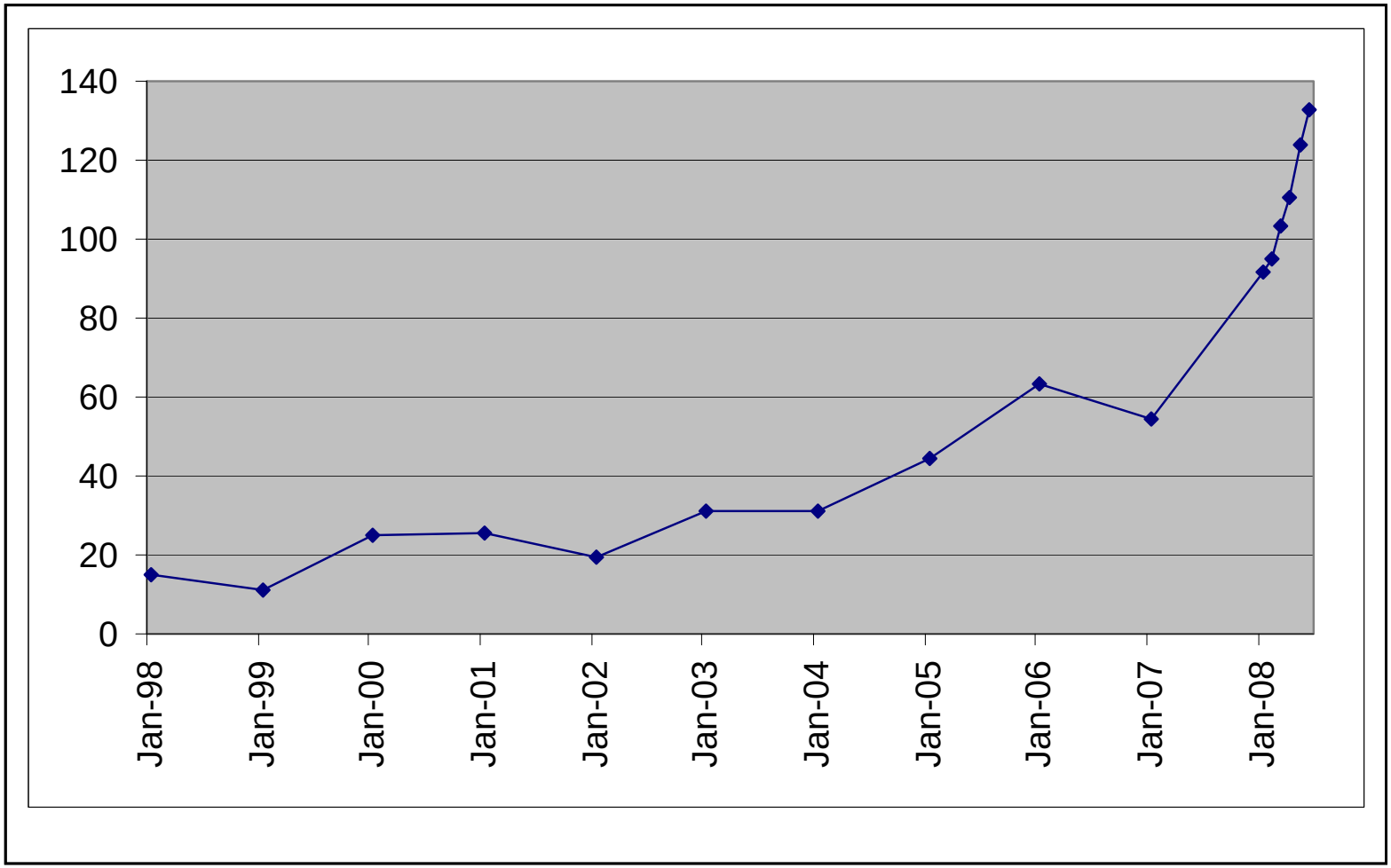
The Age of Oil



Source: J.E Naber and F. Goudriaan

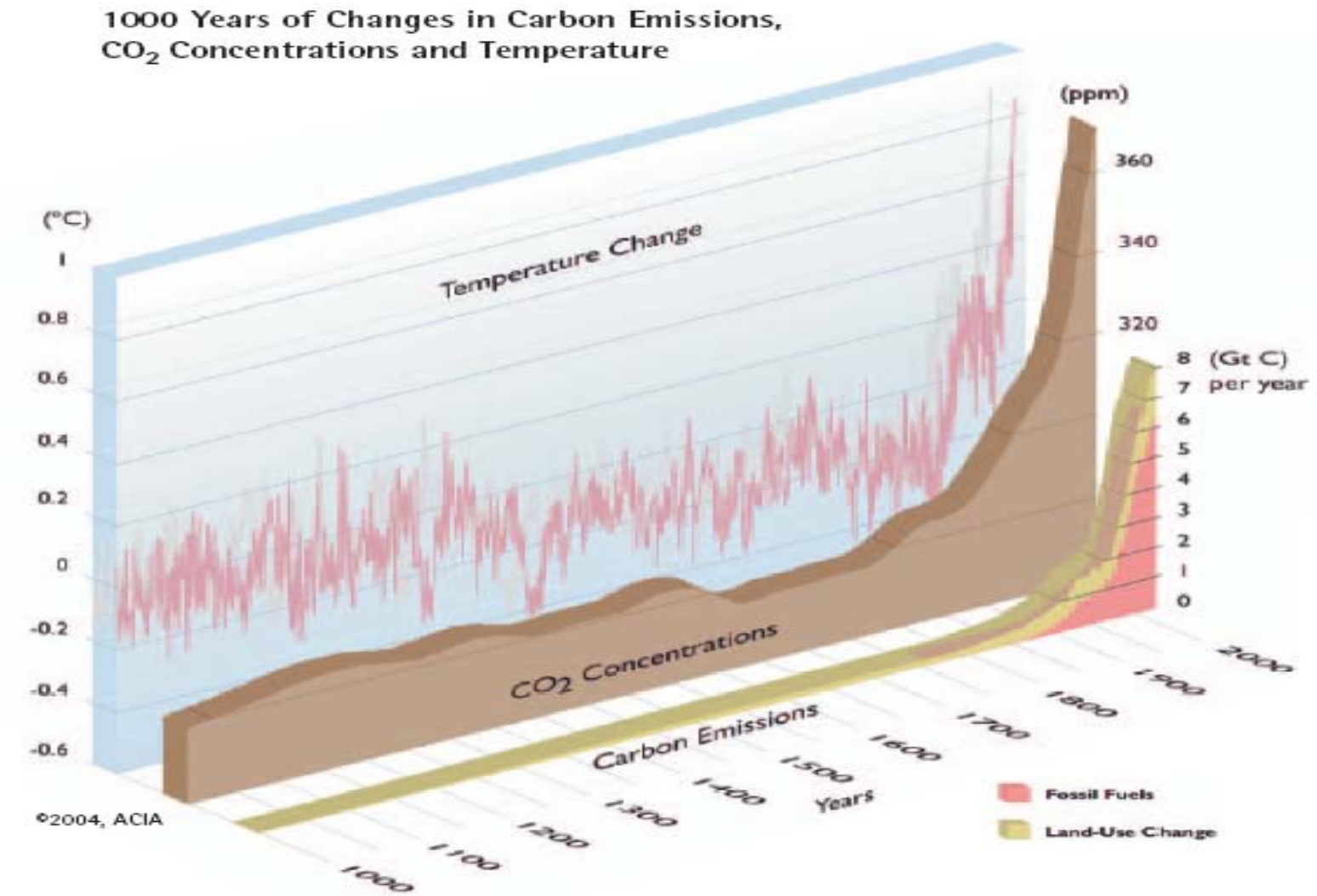
Cheap Energy Era Is Over

$/barrel*



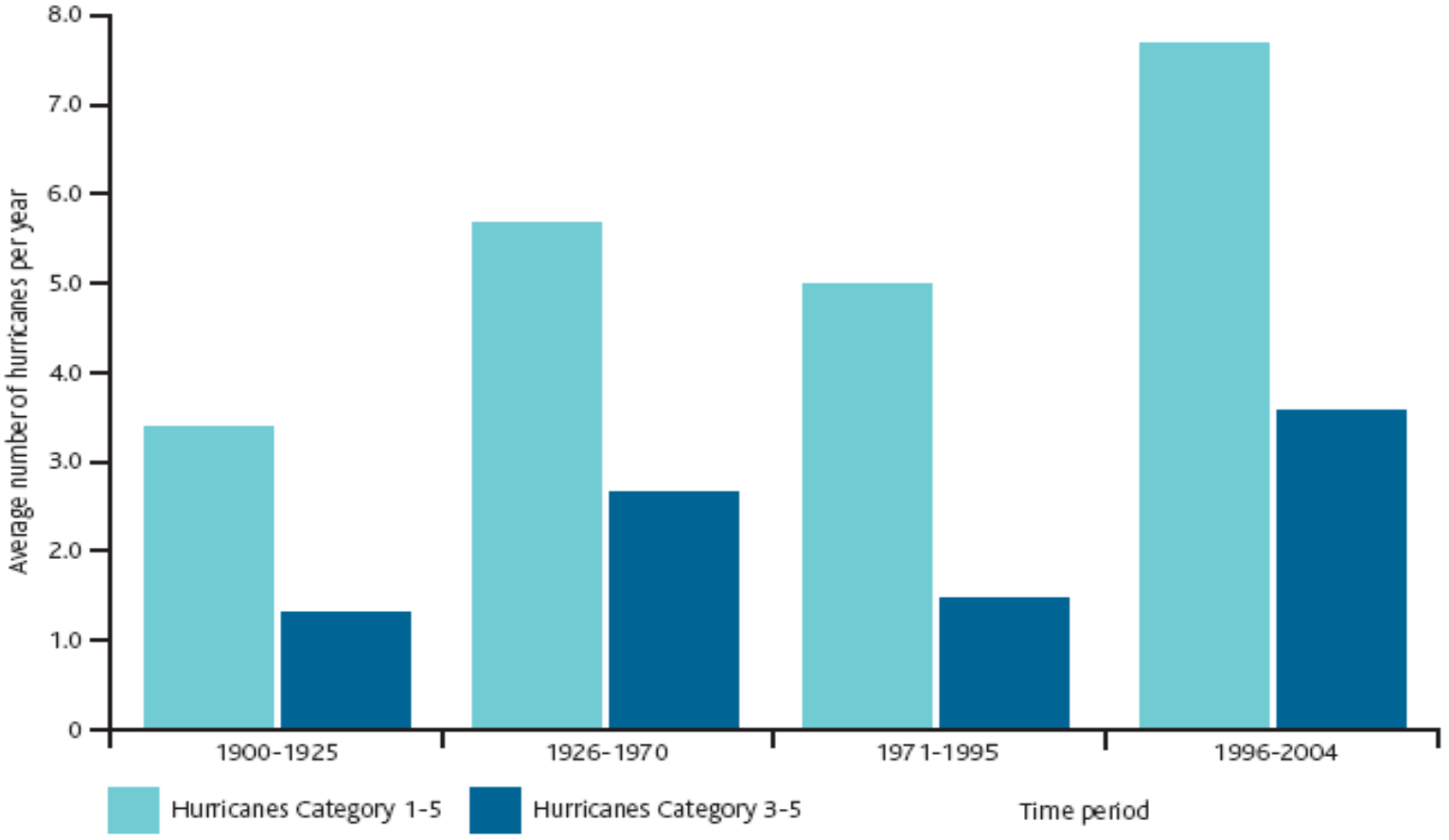
Crude Oil (petroleum); Dated Brent - Monthly
Price - Commodity Prices Value

Climate Change Era Beginning



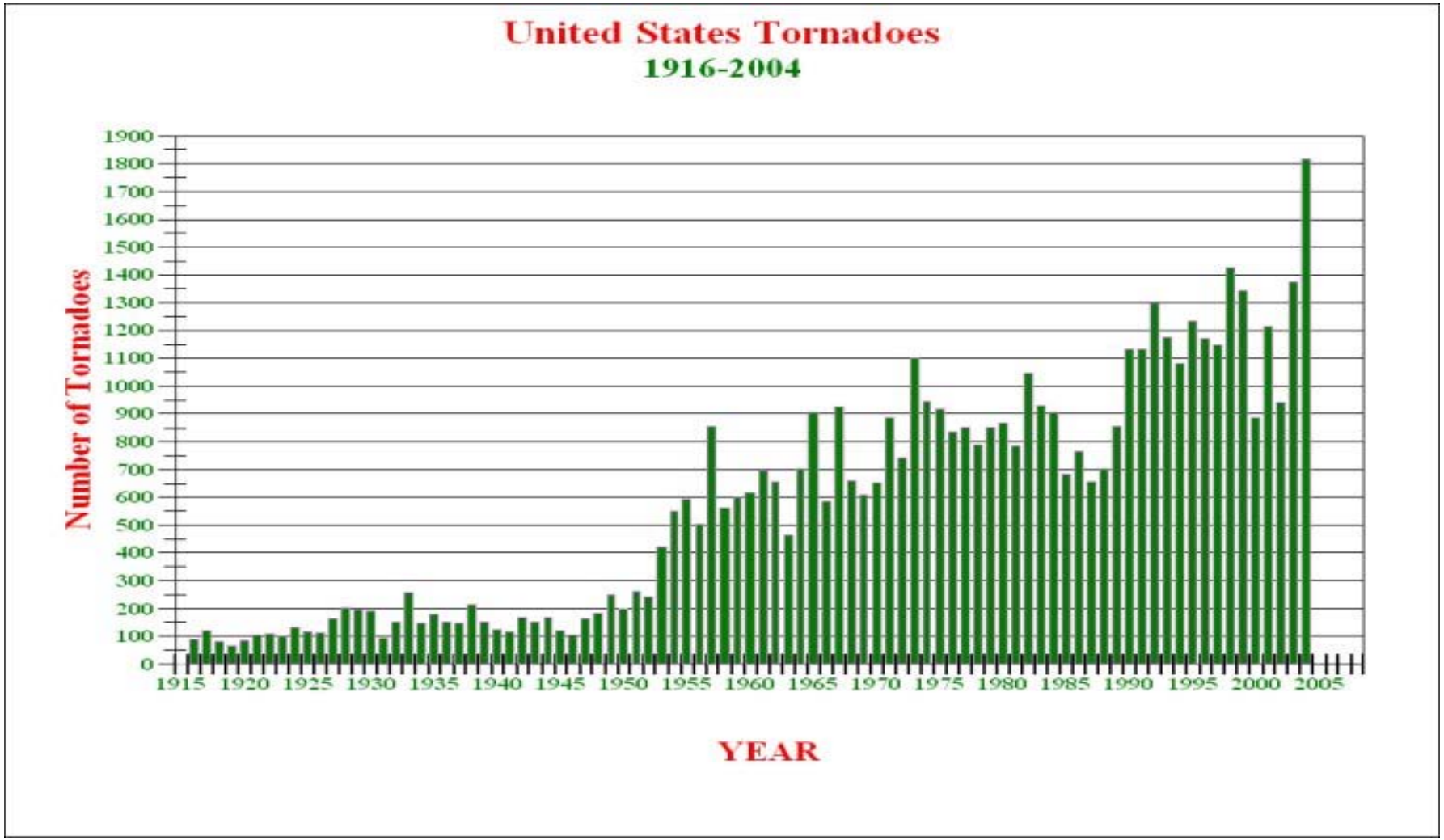
Source: “Impacts of a warming Arctic: Arctic Climate Impact Assessment”, Cambridge University Press. 2004.

U.S. Atlantic Hurricanes



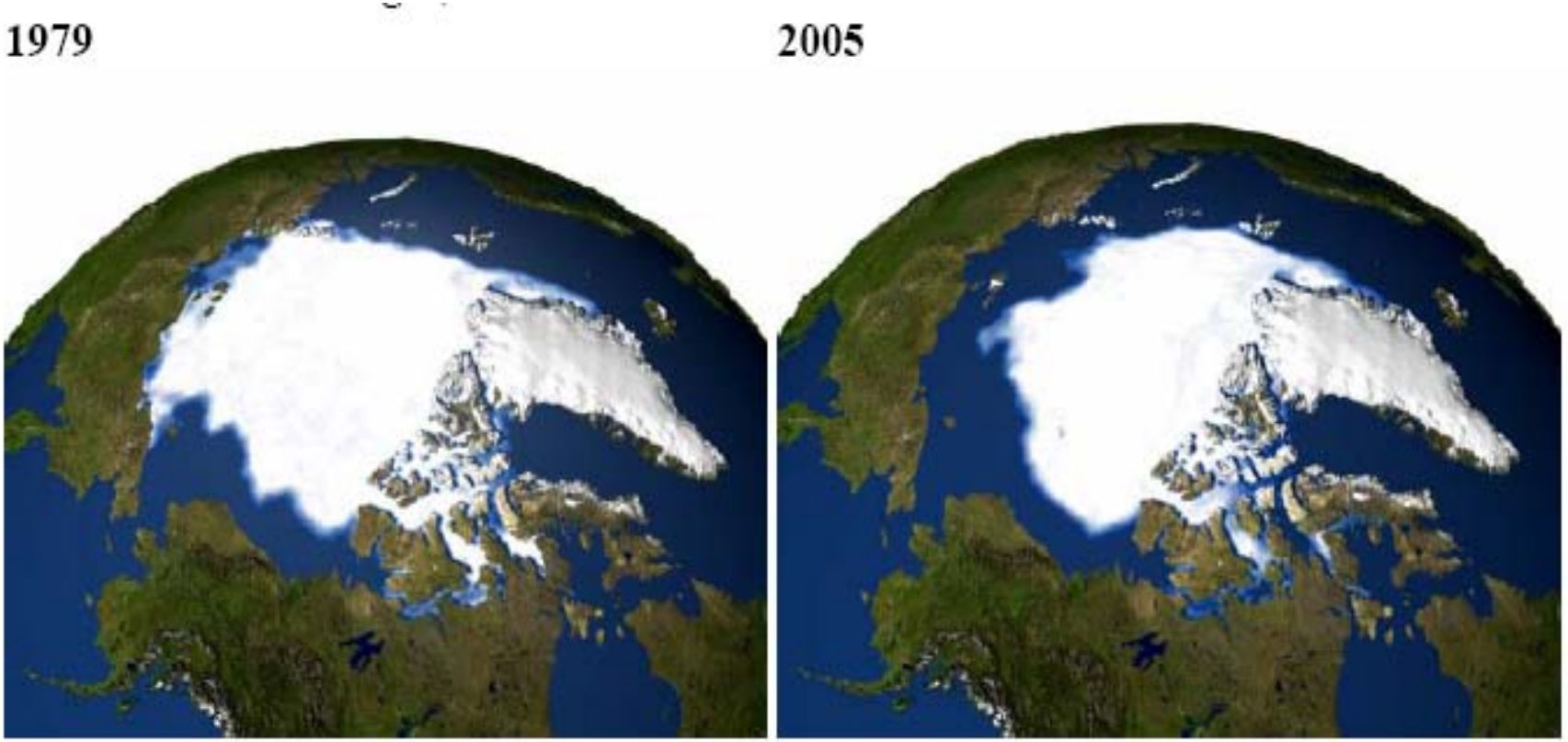
Source: www.abi.org

Increasing U.S. Tornadoes



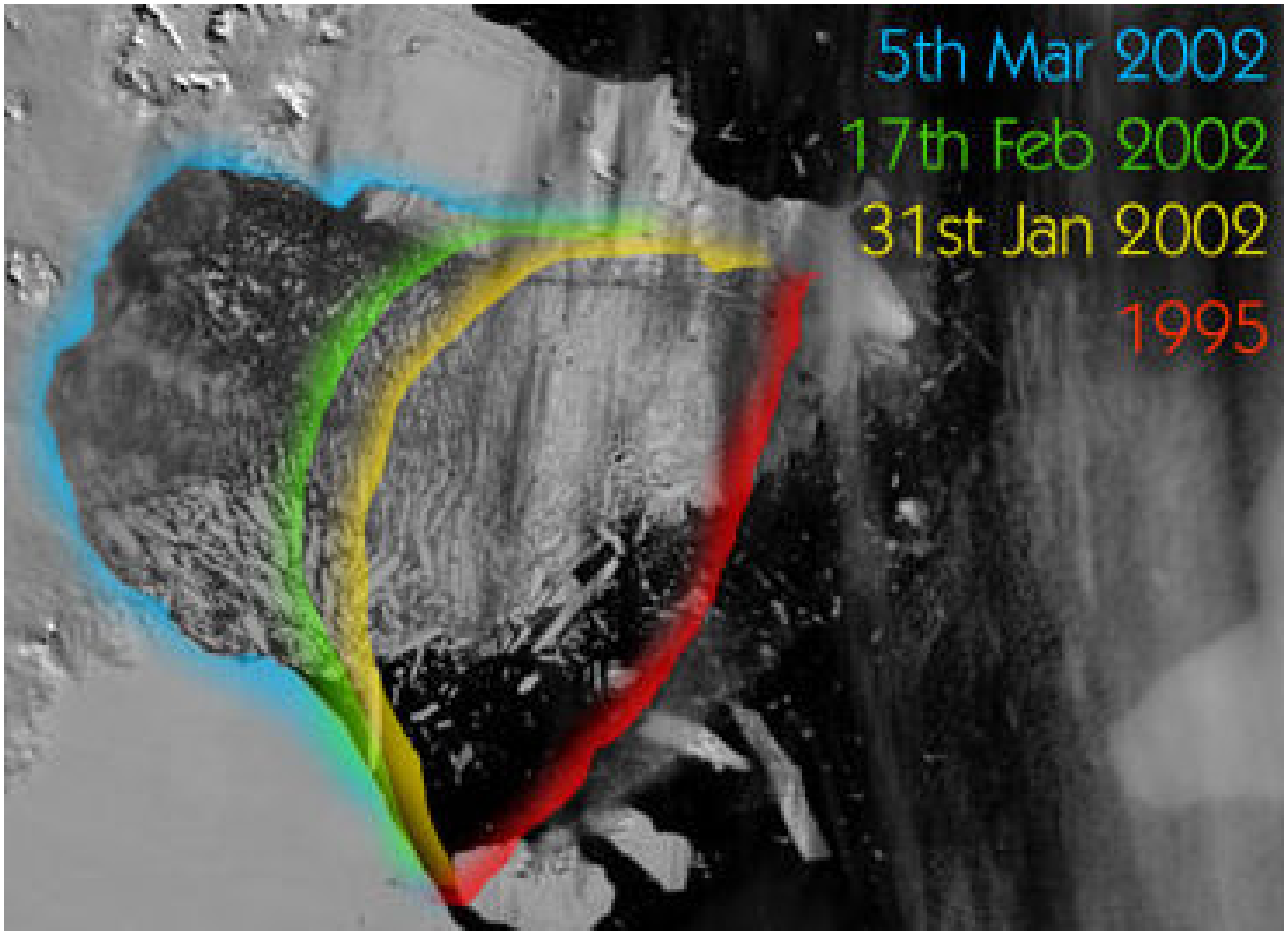
Source: US Severe Weather Meteorology and Climatology

Melting Polar Ice Caps



Source: “Impacts of a Warming Arctic: Arctic Climate Impact Assessment”, Cambridge University Press. 2004.

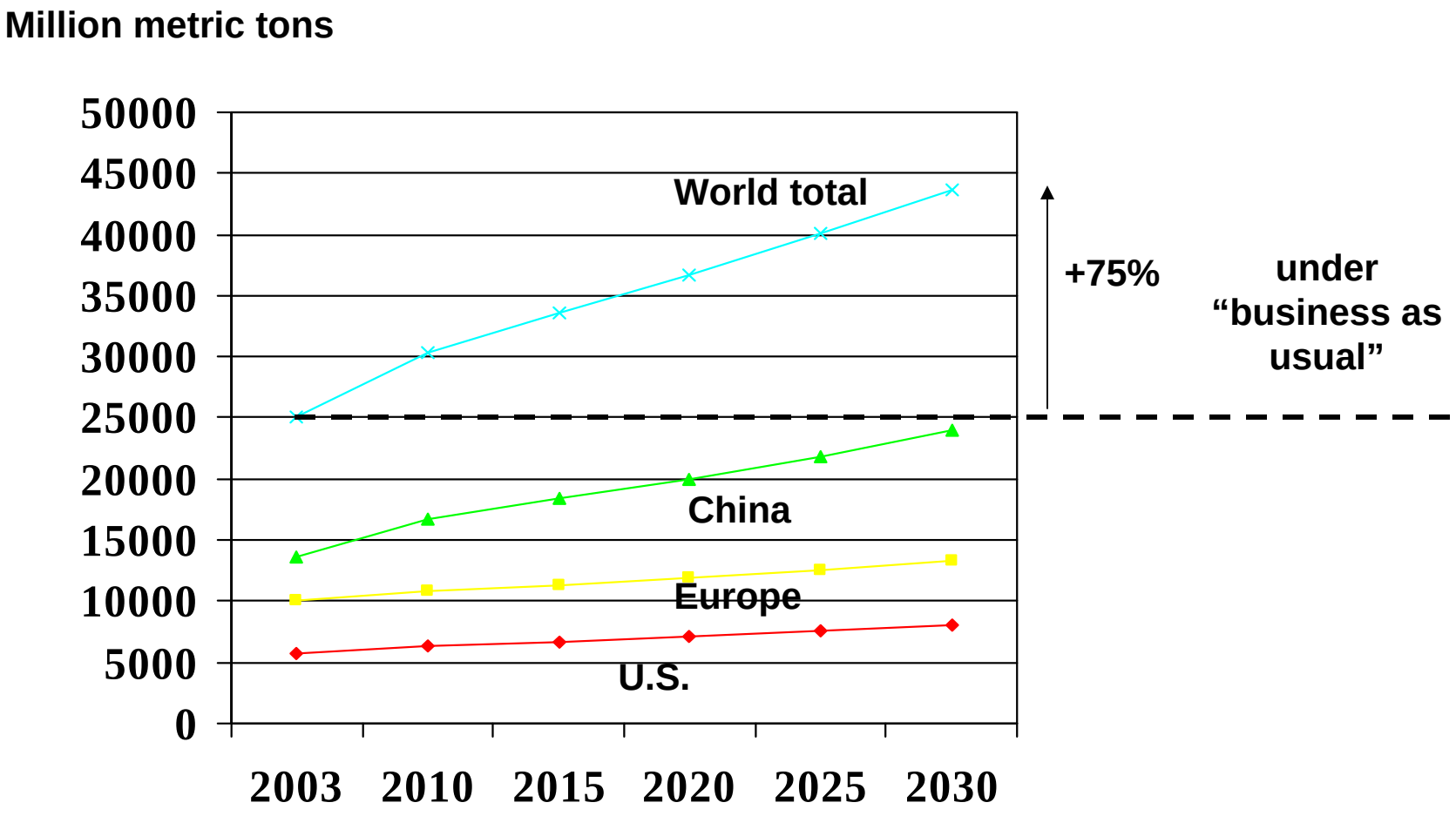
Larsen Ice Sheet Collapse



3250 km^2 (20% bigger than Rhode Island)

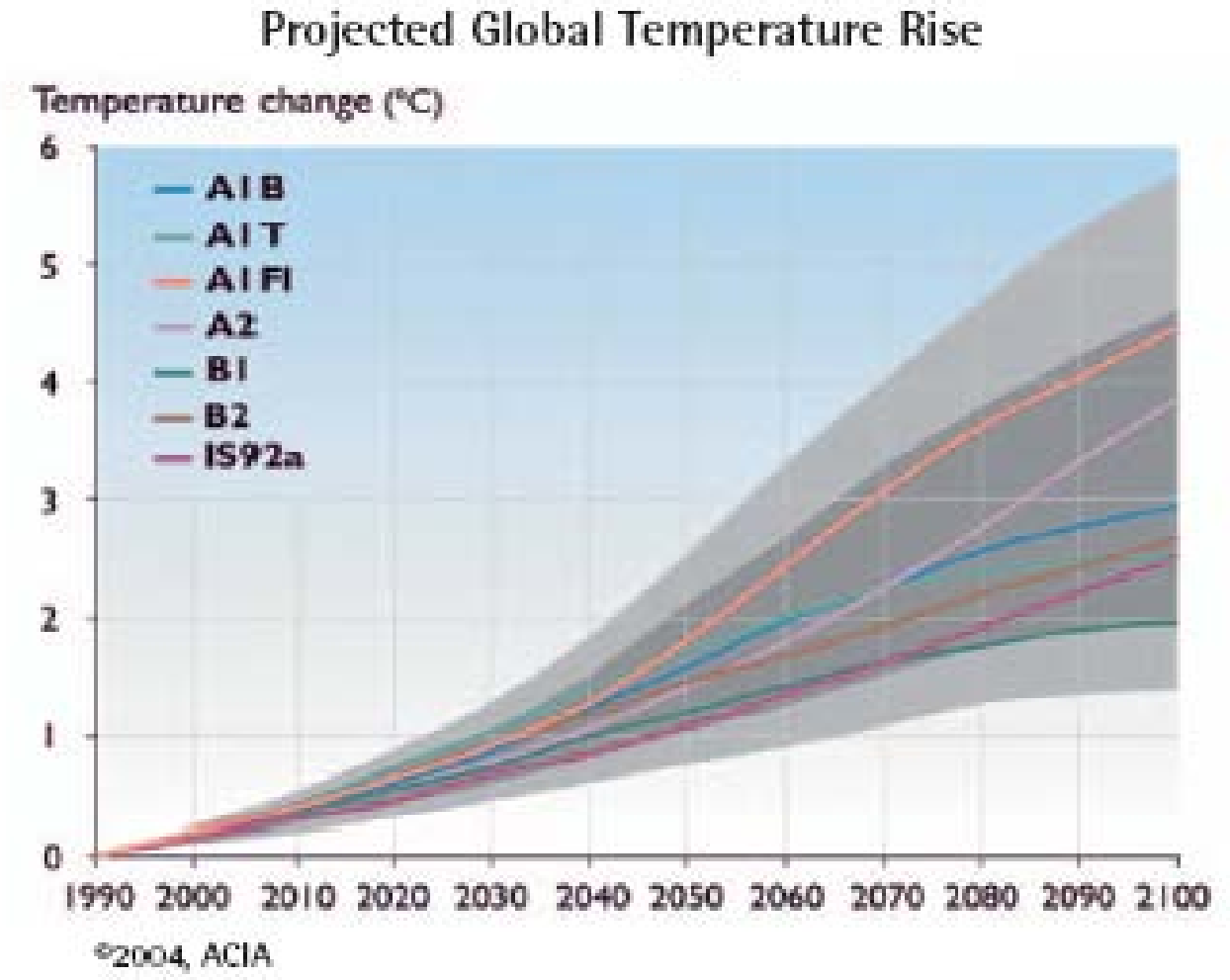
Source: www.uweb.ucsb.edu/~christowilson/science.htm

Future CO_2 Emissions Growth



Source: EIA International Energy Outlook

Increasing Global Temperatures



Source: "Impacts of a warming Arctic: Arctic Climate Impact Assessment", Cambridge University Press. 2004.

Remember:

Temperature increases greater than average at the poles

Temperature lags CO_2 concentrations by about 50 years

CO_2 emissions remain in the atmosphere for about 100 years

Opportunity: Advanced Energy

- **Multi-trillion dollar "conventional" energy paradigm increasingly unlikely to meet the twin challenges of increasing oil scarcity and climate change**

- **To cope with these challenges, enormous "advanced" energy industry will need to be built in coming decades**

- **Accelerating the transition to advanced energy locally not only represents economic opportunity, but also prospect for improving local performance on energy and environmental metrics**

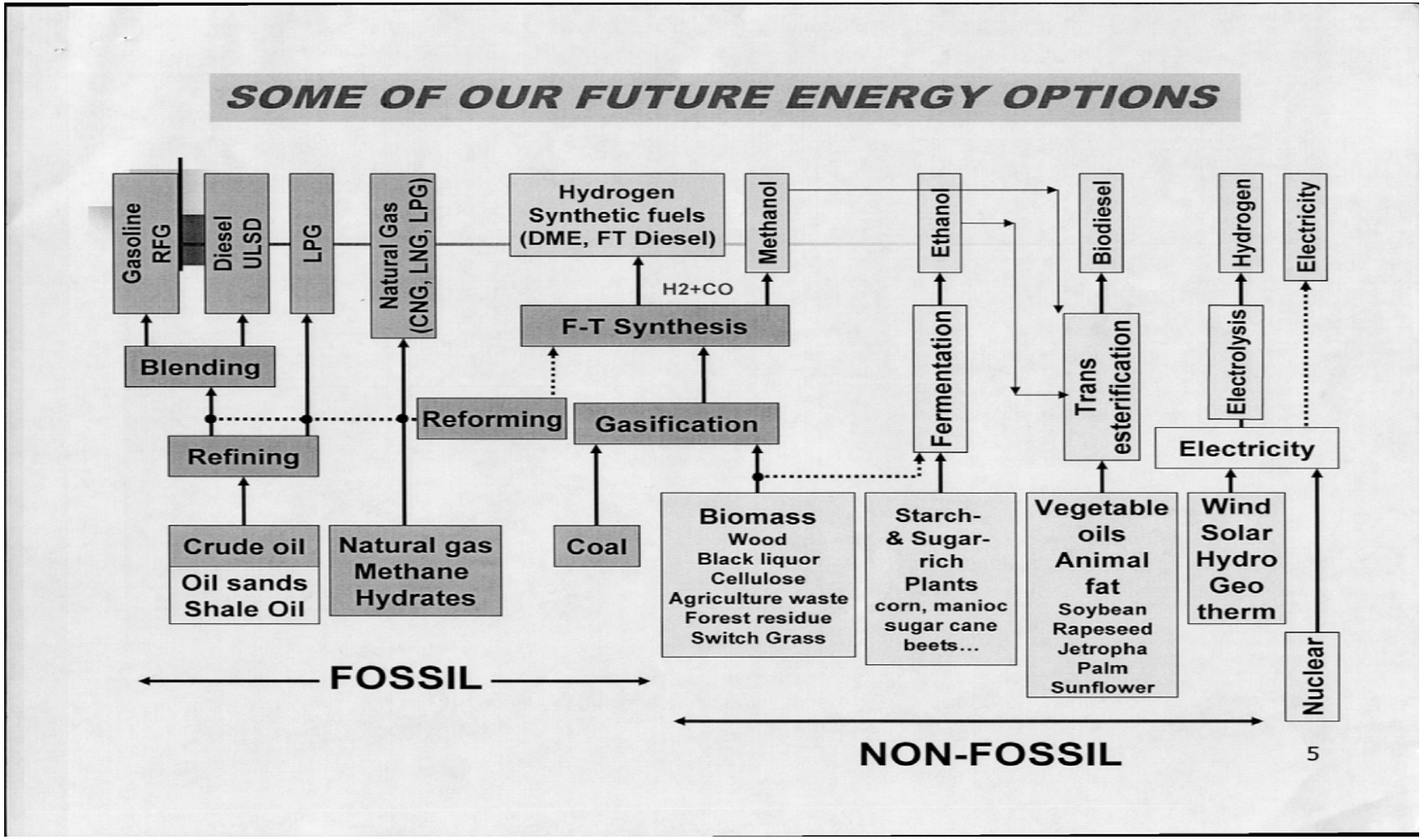
What is Advanced Energy?

- **More efficient use of energy to reduce overall energy requirement**
  - **Drivetrain technologies and alternative transportation**
  - **Lighting, HVAC and building technologies**

- **Lower net-carbon forms of energy supply**
  - **Renewables (e.g., wind, solar, geothermal, ocean)**
  - **Bioenergy (for power generation and transportation)**
  - **Hydrogen and fuel cells**
  - **Fossil fuels @ reduced carbon levels**
  - **Nuclear**

- **Ancillary technologies to facilitate reduced energy consumption and lower carbon energy supply**
  - **Energy storage (electricity, hydrogen)**
  - **Information technologies**

Advanced Energy System



Source: John R. Wilson, TMG/ENERGY, Detroit.

Why Pursue Advanced Energy?

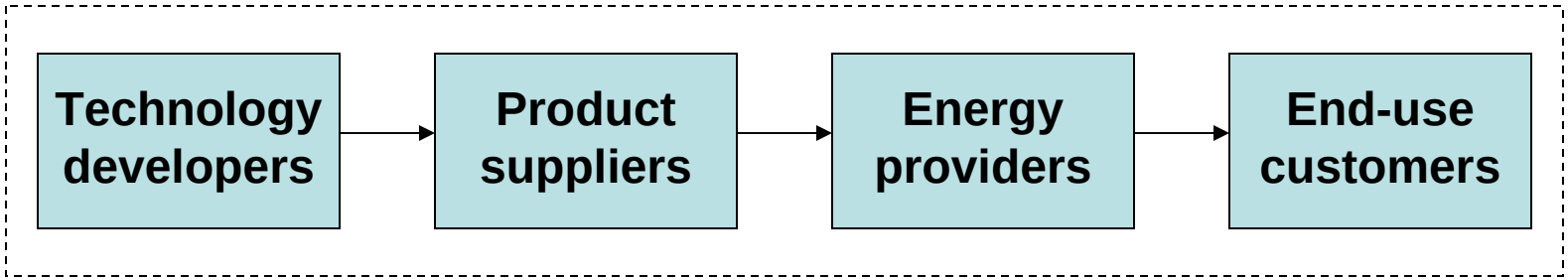
- Peak oil and climate change → reinvention of enormous energy industry in coming decades
- Our industrial heritage, competences and assets provide basis for success in emerging advanced energy industry
- Side-benefits: reduction in our air emissions and our exposure to increasing energy prices

Why Ohio for Advanced Energy?

- **Materials science leadership**
- **Significant manufacturing resources**
- **Geographic location → distribution advantages**

Building Advanced Energy Industry

"The Market"



Outside forces shaping "The Market"

- **Government agencies: set policies and enforce laws that promote technology development/adoption and market structures (e.g., electricity/gas regulation)**
- **Universities/research institutions: conduct basic research (often with private sector partners) for future commercialization of technologies and products**
- **Industry/trade groups: self-organize to shape the emergence/growth/structure of the market and supply chain**
- **Facilitating organizations: help the parties in various targeted ways to promote the health of the market**

Ohio Government Agencies

- **Environmental Protection Agency: regulates air/water emissions and waste treatment from Ohio sources**
- **Department of Natural Resources: protects land and water assets of Ohio**
- **Department of Development: supports the interest of businesses to promote economic development and job creation in Ohio:**
  - **Third Frontier: funds the development of new technologies among Ohio universities and businesses**
  - **Office of Energy Efficiency: administers programs (including Energy Loan Fund) to encourage energy efficiency and renewable energy adoption in Ohio**
- **Air Quality Development Authority: provides low-interest sources of financing for energy-related projects in Ohio**
- **Public Utilities Commission: implements policies and sets prices for regulated electric/gas service in Ohio**
  - **Biomass Program: encourages the utilization of Ohio biomass resources for energy purposes**
- **Consumers' Counsel: represents Ohio residential consumers' interests in electric/gas regulatory proceedings**

Universities and Research Institutions

- **Battelle: significant research in fuel cells, batteries, combustion, sequestration**
- **Case Western Reserve University: Institute of Energy Innovation focusing on renewable energy, fuel cells, energy storage, energy efficiency**
- **Cleveland State University: major center for sensors and controls**
- **NASA Glenn Research Center: pioneer in wind technology, active in fuel cells and PV**
- **Ohio State University: leader of Ohio coal research consortium, major ag/bio research center (OARDC), active in most energy disciplines (fuel cells, solar, electric vehicles, etc.)**
- **Ohio University: significant coal-based research agenda, Voinovich Center for Energy, Economics & Environment (CE3)**
- **University of Akron: world leadership in polymers and materials**
- **University of Toledo: world leader in thin-film PV technologies, significant hydrogen research**

University Clean Energy Alliance of Ohio (UCEAO)

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Industry and Trade Groups

Energy related

- Ohio Coal Association: encouraging the use of Ohio coal on behalf of its producers
- Ohio Oil and Gas Association: serving the independent oil/gas producers based in Ohio
- Ohio Fuel Cell Coalition: promoting the development of fuel cell industry activity in Ohio
- Ohio Advanced Energy: advocating policies in Ohio to support the emergence of advanced energy businesses
- Energy Industries of Ohio: seeking to improve the competitiveness of Ohio industry through enhanced energy efficiency
- Great Lakes Wind Network: expanding the supply chain of companies selling in the wind industry
- Ohio Wind Working Group: working to streamline wind energy development process in Ohio
- Green Energy Ohio: expanding Ohio public awareness of renewable energy
- Green Building Coalition: supporting the development of buildings with high energy efficiency and low environmental impact
- Industrial Energy Users: representing the interests of large energy consumers in electric/gas regulatory proceedings

Other important groups with significant energy interests

- Ohio Manufacturers Association
- Ohio Farm Bureau
- Ohio Environment Council
- Environment Ohio

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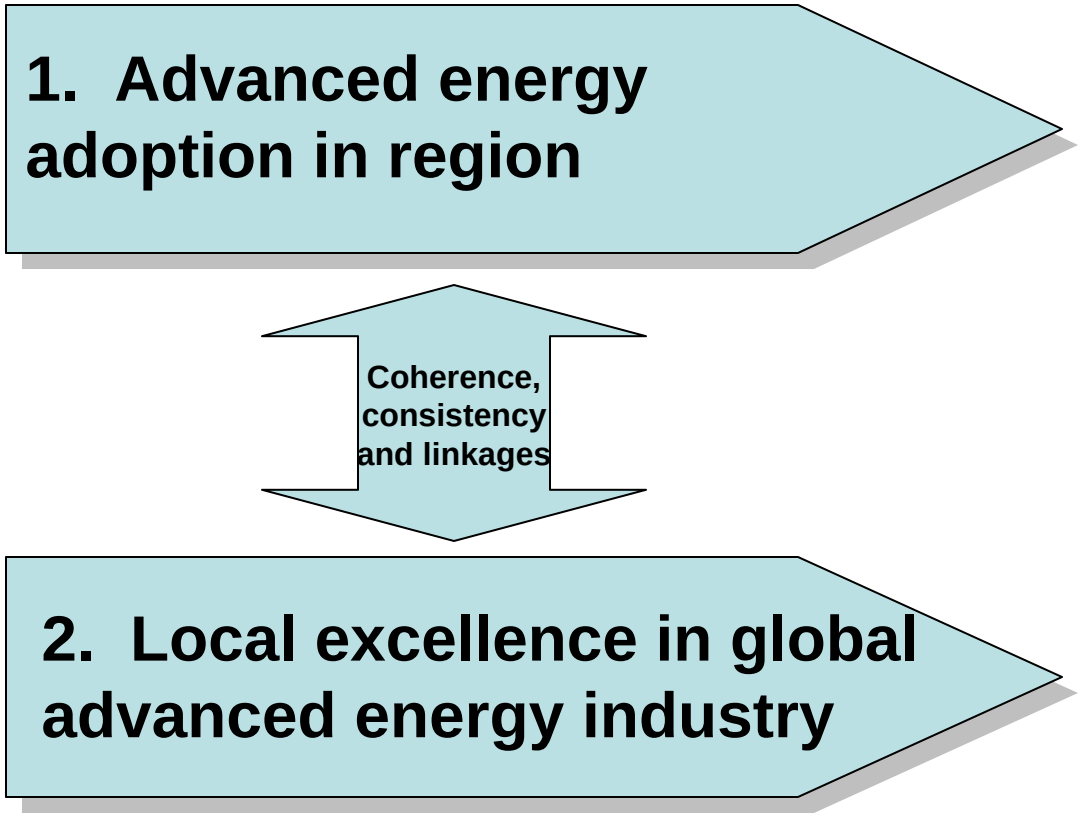
Facilitating Organizations

- **Port Authorities (e.g., Cleveland/Cuyahoga County): supporting site/facility procurement and providing low-interest financing**
- **Team NEO: assisting companies seeking to come to region in site selection and set-up**
- **WIRE-Net: working with smaller area manufacturers to reposition their businesses to serve new industry requirements**
- **Cuyahoga Community College (Tri-C): training workforce to meet new needs of emerging industry**
- **JumpStart: providing seed equity capital to incubate advanced energy ideas into financeable ventures**
- **NorTech: undertaking efforts to increase regional capacities for entrepreneurism and innovation**

Regional Advanced Energy Strategy



Results

- Reduced expenditures on energy
- Improved local air quality, and reduced contributions to global climate change

- Increased economic activity
- Technological leadership and culture of innovation
- Improved public pride and civic reputation

Recent Highlights

- **Passage of new Ohio energy law, including significant requirements for energy efficiency and renewable energy adoption**
- **Activities to attract foreign advanced energy companies and support expansion of local companies into advanced energy markets**
- **Launching of Great Lakes Institute of Energy Innovation (including 3 new research professorships) at Case Western Reserve University**
- **$1 million feasibility study to investigate demonstration project and research center for offshore wind**
- **Exploration of possibilities to collaborate with China on advanced energy**

Ohio Advanced Energy Market

- **Ohio utilities must obtain 25% of power from advanced energy sources by 2025:**
  - **At least ½ (12.5%) from renewables (of which 0.5% must be solar)**
  - **At least ½ from plants installed in Ohio**
- **Renewable requirements begin by end of 2009, ramp-up to 2025:**
  - **4,500 estimated MW wind installed**
  - **450 estimated MW solar installed**
- **22% reduction in electricity demand also required by 2025**

Other Ohio Financial Support

- $150 million (grants and low-interest loans) over next 3 years to deploy advanced energy projects in Ohio
  - $66 million for advanced coal
  - $84 million for other
- $24 million in technology development grants in 2009 for advanced energy
  - $11 million for fuel cells
  - $13 million for other
- $3000 per student intern per year to support workforce development

Many local (city/municipal and county) incentives also available

Business Attraction and Expansion

- **Attraction:**
  - **IBC Solar**
  - **Several wind manufacturers considering Ohio**
  - **Fuel cell companies**
- **Expansion:**
  - **Great Lakes Wind Network assisting regional manufacturers**

Case Western Reserve University: Great Lakes Institute of Energy Innovation

- **Launched late 2007 with grants from Cleveland Foundation and Maltz Foundation, under Dean Norman Tien (School of Engineergin)**
- **Purpose: to integrate energy-related research across CWRU's departments and schools into one focal point for better collaboration and external interface**
- **Goal: to re-establish CWRU as one of the world's leading engineering schools and attract best/brightest students (and future entrepreneurs), using energy/environment as the main research priority**
- **Key people:**
  - **Faculty Director: Iwan Alexander**
  - **Executive Director: Dianne Anderson (former BP executive)**
  - **3 faculty positions in renewables, energy storage, energy efficiency**

Long-Term Wind Vision

- **Cleveland as a major North American center of wind technology R&D and manufacturing**
- **Ohio and other neighboring states as a large market for onshore wind deployment**
- **Great Lakes (starting with Lake Erie) as a growing market for offshore wind installation, with Cleveland as primary logistics hub**

Great Lakes Wind Energy Center

- **Two components:**
  - **5-20 megawatt demonstration project (2-10 turbines) 3-6 miles offshore downtown Cleveland**
  - **Affiliated research/testing center for new wind technology R&D**

- **Purposes:**
  - **Attract research, manufacturing and services for future global offshore wind industry**
  - **Set precedents and improve economics for subsequent offshore wind project development in Great Lakes**
  - **Create powerful visual icon for Cleveland**

- **2008: detailed feasibility study to ensure viability of concept**

Closing Comments

- **Energy industry in crisis: oil supply scarcity and climate change**
- **New energy industry must be built in coming decades**
- **Accelerating transition to advanced energy in our region represents major economic opportunity, and will improve performance on key energy and environmental metrics**
- **NASA Glenn has a key role to play in inventing the new energy economy – here in Ohio!**

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