
University of Michigan Energy Research

Yesterday, Today & Tomorrow

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College of Engineering
National Advisory Committee Meeting
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Motivation

There are few contemporary challenges facing our nation more threatening than the unsustainable nature of our current energy infrastructure.

Every aspect of contemporary society is dependent upon the availability of clean, affordable, flexible, and sustainable energy resources.



The Challenge

- Our current energy infrastructure, heavily dependent upon hydrocarbons, is unsustainable.
- Our environment is seriously impacted by current energy sources.
- The security of our nation is threatened by our reliance on foreign energy imports.
- Both the nation and major research universities such as UM must give a far higher priority to energy research.

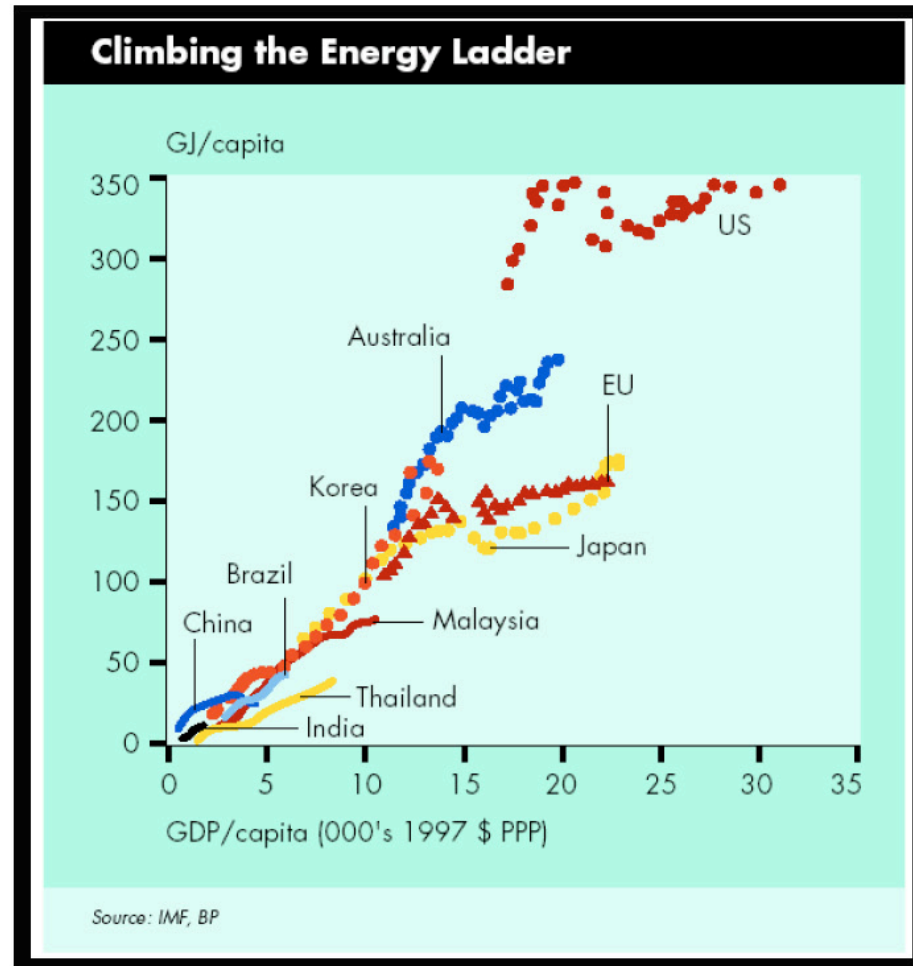
The World Energy Challenge ...

A product of concurrent and connected trends

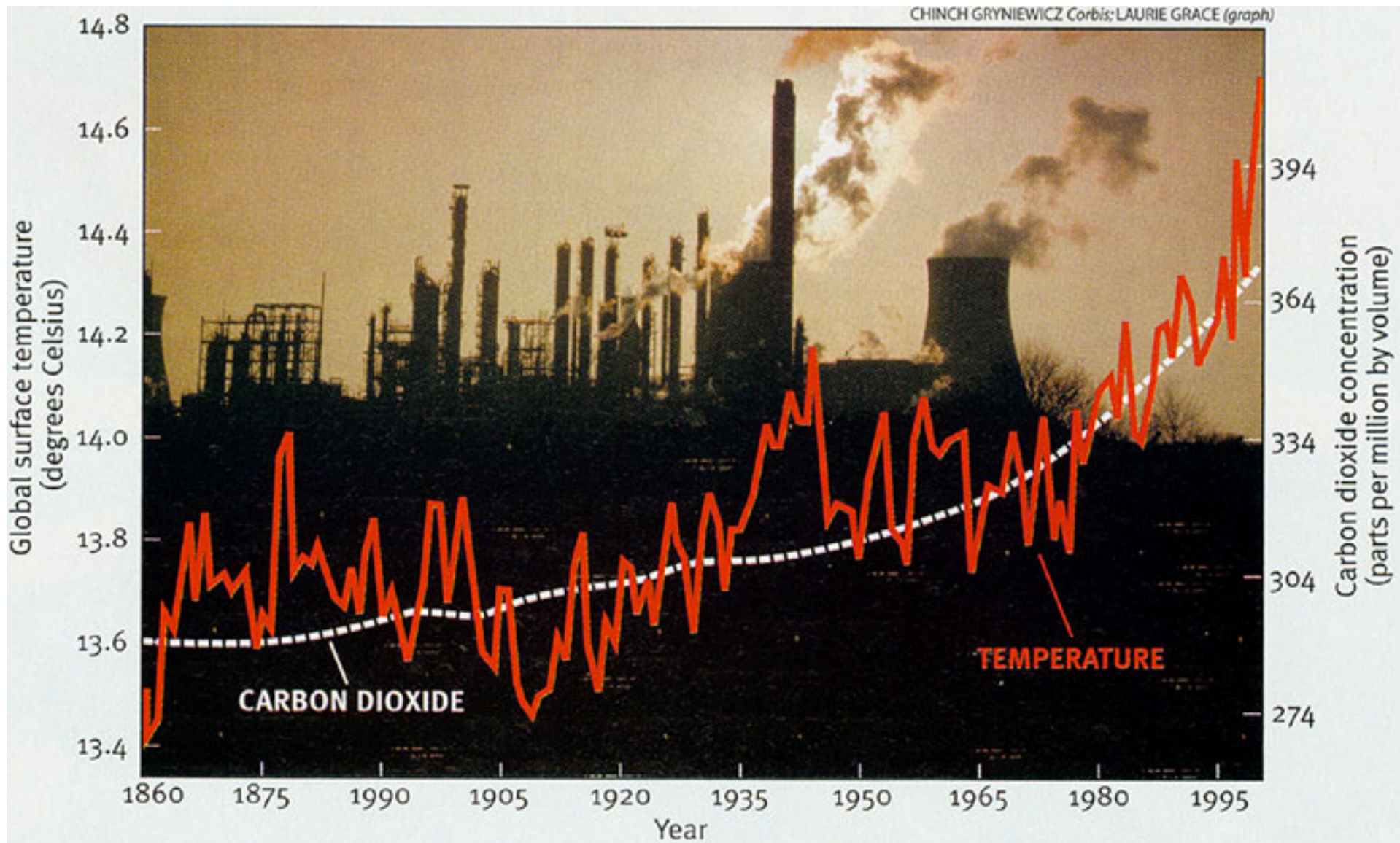
- **Population:** Estimated 9 billion by 2050
- **Economics:** People producing & consuming more
- **Environment:** Too much CO₂ for earth to absorb
- **Energy Sources:** Declining world oil production



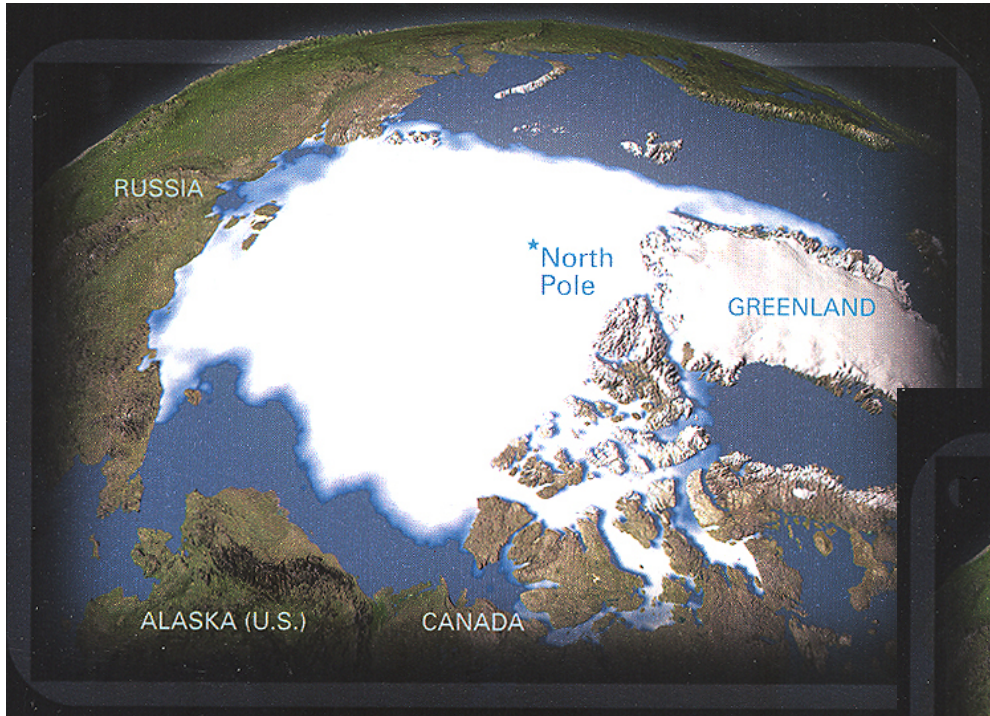
Economic Prosperity Requires Reliable and Affordable Energy



Source: Royal Dutch Shell, "Exploring the Future – Energy Needs, Choices and Possibilities"

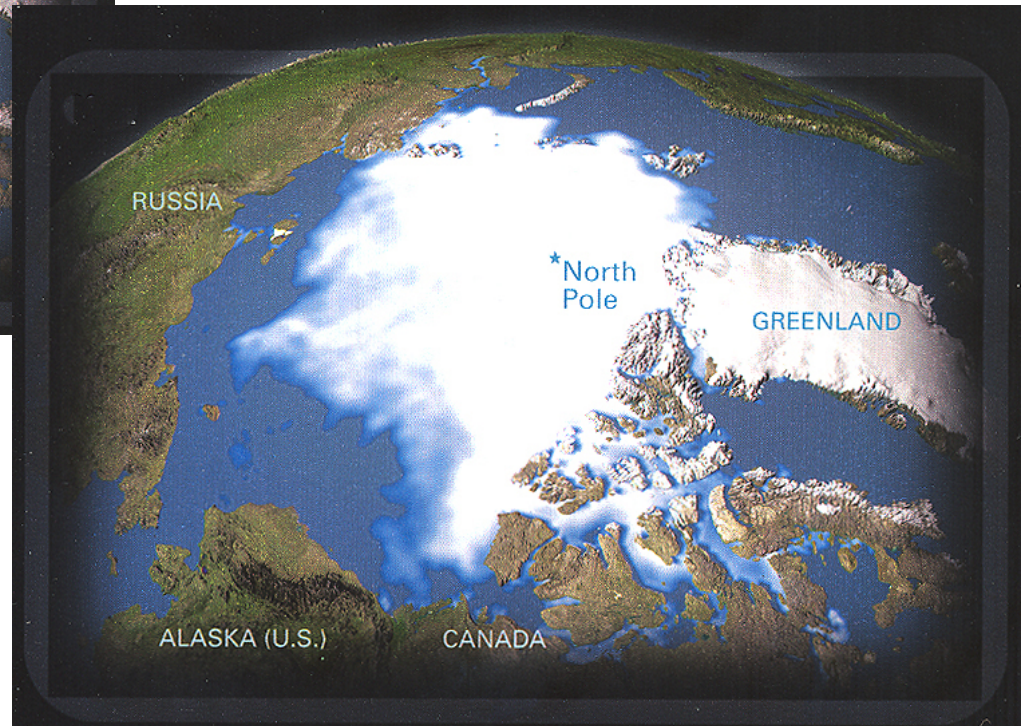


Arctic Ice Cap Change



1979

2003





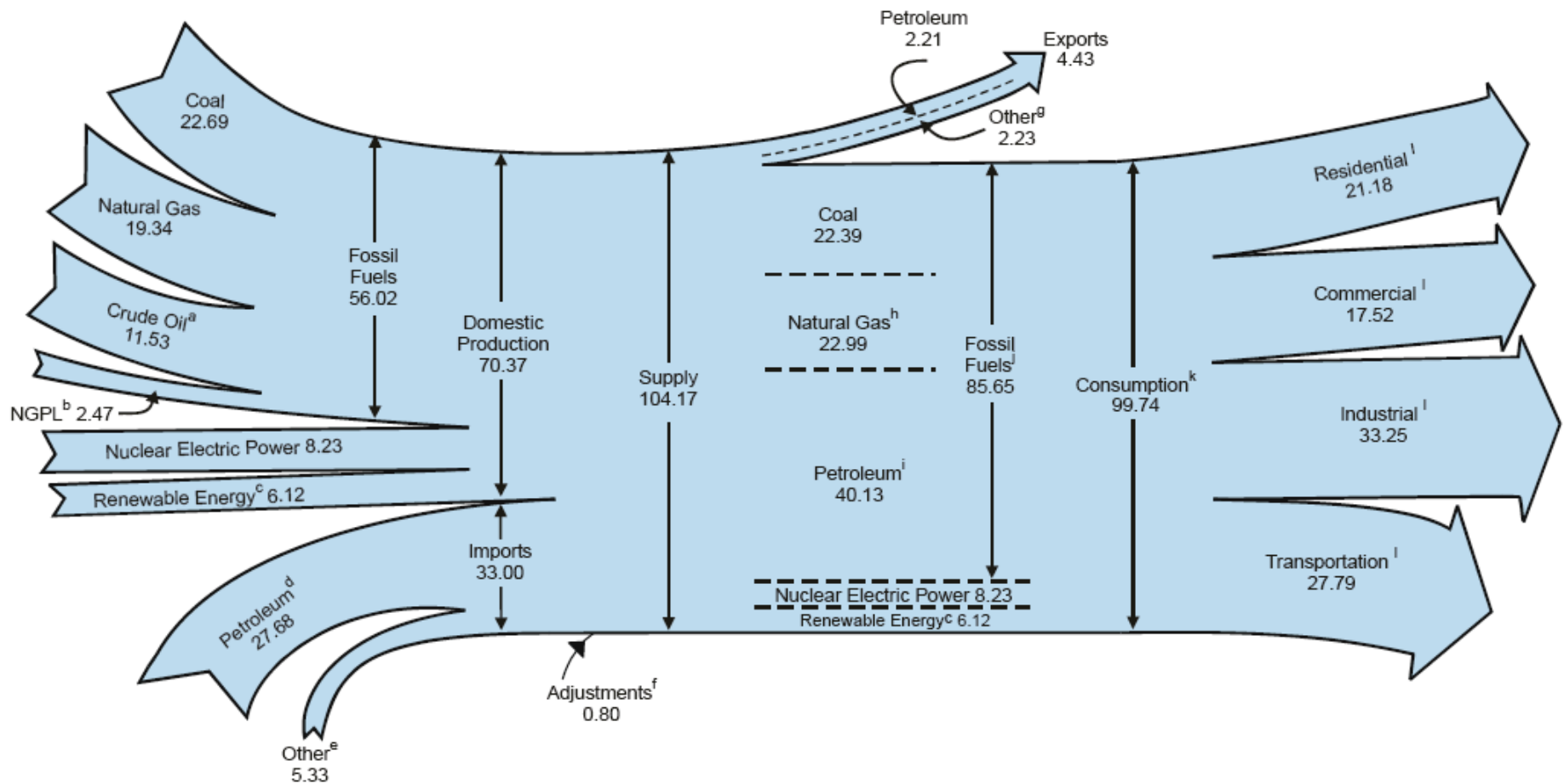
M. King Hubbert's Peak

- U.S. oil production peaked in the 1970s
 - **The imbalance between domestic production and consumption has led to our extreme dependence on Middle East oil**
- When will global oil production peak?
 - **Certainly some time during this century.**
 - **Within next few decades?**
 - **Within next decade?**
- Note the disruption that will occur when global consumption exceeds production!

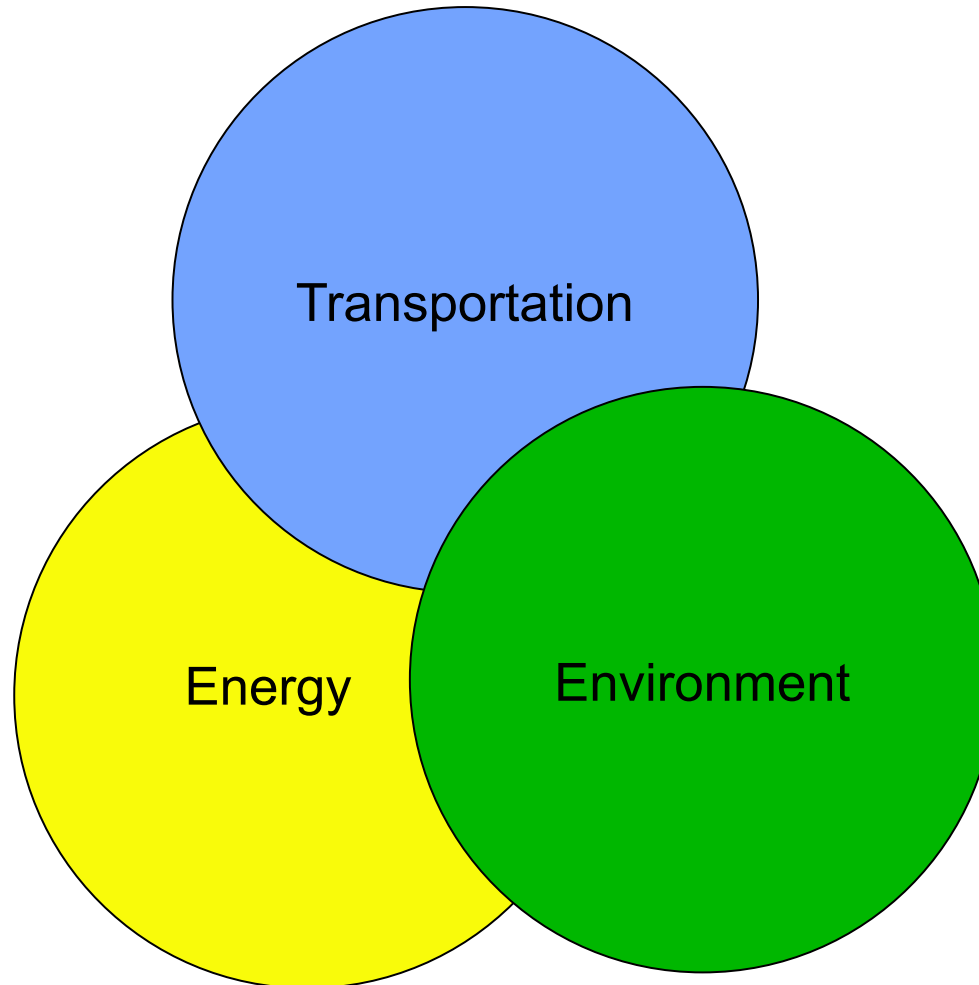
Table II-1. Projections of the Peaking of World Oil Production

<u>Projected Date</u>	<u>Source of Projection</u>	<u>Background & Reference</u>
2006-2007	Bakhitari, A.M.S.	Iranian Oil Executive ¹¹
2007-2009	Simmons, M.R.	Investment banker ¹²
After 2007	Skrebowski, C.	Petroleum journal Editor ¹³
Before 2009	Deffeyes, K.S.	Oil company geologist (ret.) ¹⁴
Before 2010	Goodstein, D.	Vice Provost, Cal Tech ¹⁵
Around 2010	Campbell, C.J.	Oil company geologist (ret.) ¹⁶
<hr/>		
After 2010	World Energy Council World Non-Government Org. ¹⁷	
2010-2020	Laherrere, J.	Oil company geologist (ret.) ¹⁸
2016	EIA nominal case	DOE analysis/ information ¹⁹
<hr/>		
After 2020	CERA	Energy consultants ²⁰
2025 or later	Shell	Major oil company ²¹
No visible peak	Lynch, M.C.	Energy economist ²²

Diagram 1. Energy Flow, 2004
(Quadrillion Btu)

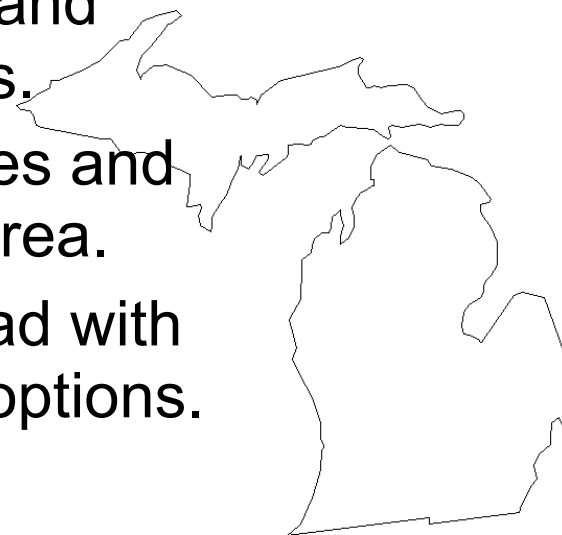


Possible Research Areas



The World Energy Challenge begins at Home

- **Jobs in Michigan.** The State employs 500,000 people who directly or indirectly design and manufacture vehicle powertrain systems.
- Until recently, the State's auto companies and their suppliers held a clear lead in this area.
- It is critical that the State maintain its lead with regard to future energy and propulsion options.



This is the right time for the College and the University to focus its attention on research and education in the important area of **energy**

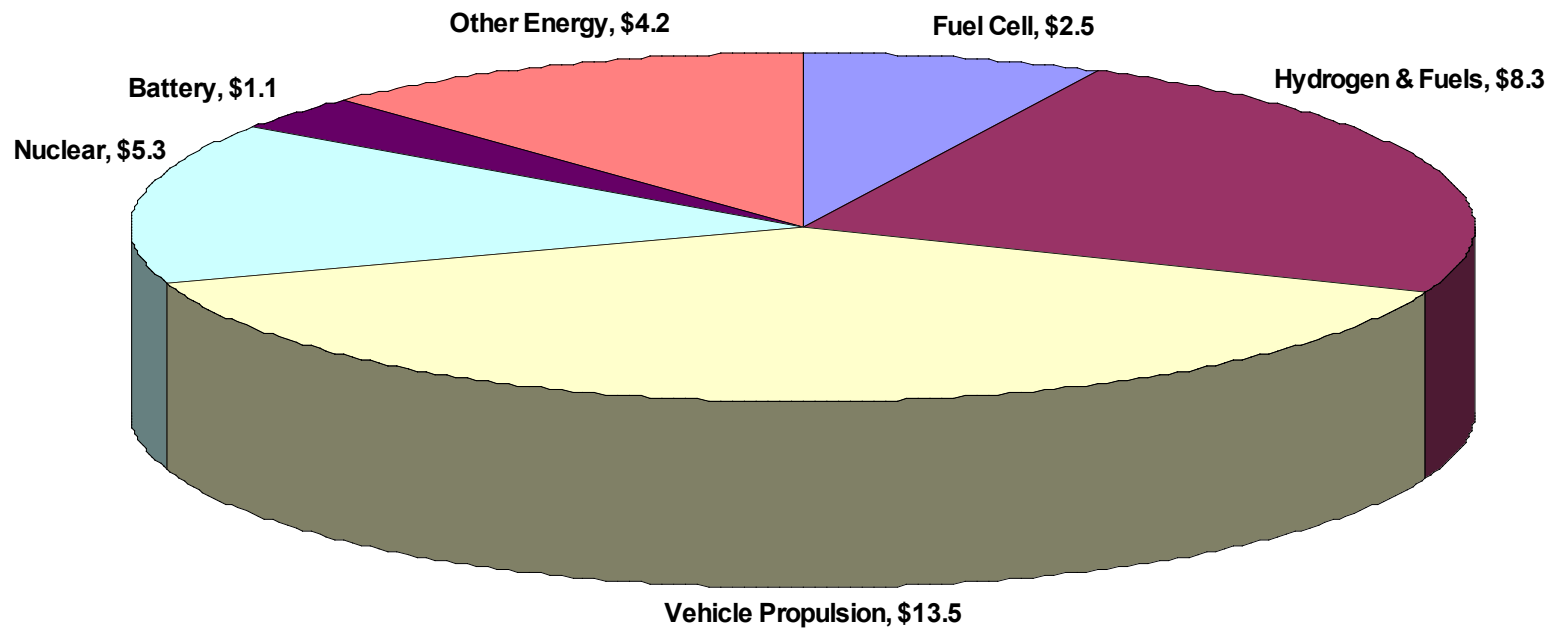
The University of Michigan has Been a Leader in Energy R&D for Many Decades

- Phoenix Nuclear Reactor – 1948
- W.E. Lay Automotive Lab – 1956
- Numerous individual research projects funded by federal agencies, the Big 3 and their suppliers over last 50 years.
- Research Centers – 1990s
 - Engineering Research Center for Reconfigurable Manufacturing (automotive focus)
 - Automotive Research Center
 - Industry Partnerships & Collaborations
- More recently, large funded projects from both DOE and DOD (TACOM).

UM Energy Research Covers a Broad Spectrum, Most of it Based in Engineering

- Advanced Energy Storage
- Biomass/Bioenergy
- Batteries
- Catalysis – Fuel Cells and Fuel Conversion
- Coal, Gas, Oil Recovery
- Electric Propulsion
- Energy Policy & Economics
- Fuel Cells
- Fuels – Traditional & Alternative
- Hybrid Vehicles
- Hydrogen Storage
- ICE and Clean Diesel
- Life Cycle Modeling
- Lightweight materials
- Manufacturing Processes
- Nuclear Energy
- Ocean Wave
- Oil Drilling and Tankers
- Sensors & Controls
- Solar
- Wind

Current UM Research on Energy and Vehicle Propulsion totals \$35M*



Total Funding = \$34.9M

** Ref: "University of Michigan Research Focusing on Energy and Vehicle Propulsion – Summaries of Current Research Activities," J. MacBain, Internal UM Report, May 16, 2005.*

Ongoing Discussions

- Possible multi-state hydrogen research initiative (DOE) (2003)
- UM Hydrogen Initiatives Committee (2004)
- Michigan Memorial Phoenix Project (2004)
- UM Energy Research Council (2005)
- Phoenix Memorial Energy Institute (2006)

UM Energy Council (2003-present)

A Renewed Energy Vision at the UM

- **Charge: “Create a vision for an advanced energy research institute at the UM.”**
 - Established at request of VP for Research, Fawwaz Ulaby
 - Chaired by President Emeritus Jim Duderstadt
 - Rededication of Michigan Memorial Phoenix Project as a University-wide Advanced Energy Initiative
- **Build upon existing strengths and resources.**
- **Plan, develop and launch the Phoenix Memorial Energy Institute.**

Michigan Memorial Phoenix Project

In May, 1948, the Regents of the University of Michigan resolved that *“the University of Michigan create a War Memorial Center to explore the ways and means by which the potentialities of atomic energy may become a beneficent influence in the life of man, to be known as the Phoenix Project of the University of Michigan.”* Construction of the Michigan Memorial Phoenix Project (MMPP) laboratory was completed in 1951. The Ford Nuclear Reactor became part of the project when it went critical in 1957 and served researchers until it was deactivated in July of 2003.

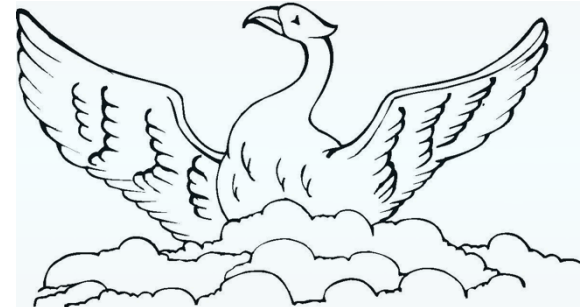
2004 Regents' Statement

To assure that its WW II memorial remain a relevant and lasting tribute to those who fought and gave their lives during the War, the University will refocus the mission of MMPP to include research on the development of energy sources and energy policies that will promote world peace, the responsible use of the environment, and economic prosperity. In doing so, it is envisioned that MMPP will become the coordinating center for research activities from a variety of disciplines that are presently dispersed across multiple schools and colleges. Research areas will include energy generation from sources such as nuclear, hydrogen, solar, wind, and geothermal, as well as energy storage, energy management, and energy policy. Research perspectives will continue to encompass the natural and social sciences, engineering, medicine, and the arts and humanities.

Phoenix Memorial Energy Institute

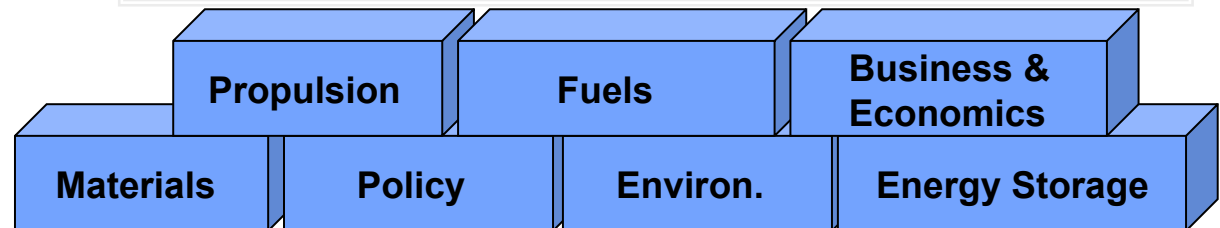
... a work in progress

- Facilitate University-wide research & education initiative
- Capture foundation, government & industry support
- Build upon existing projects and centers.
- Provide unified voice for UM energy research & education.
- Provide guidance for upgrade & expansion of UM energy research infrastructure
- Lean staff



Phoenix Memorial Energy Institute

- Workshops, short courses, and seminars
- Unified Voice for UM energy expertise
- UM Seed Funding for research initiatives, PR, and administration

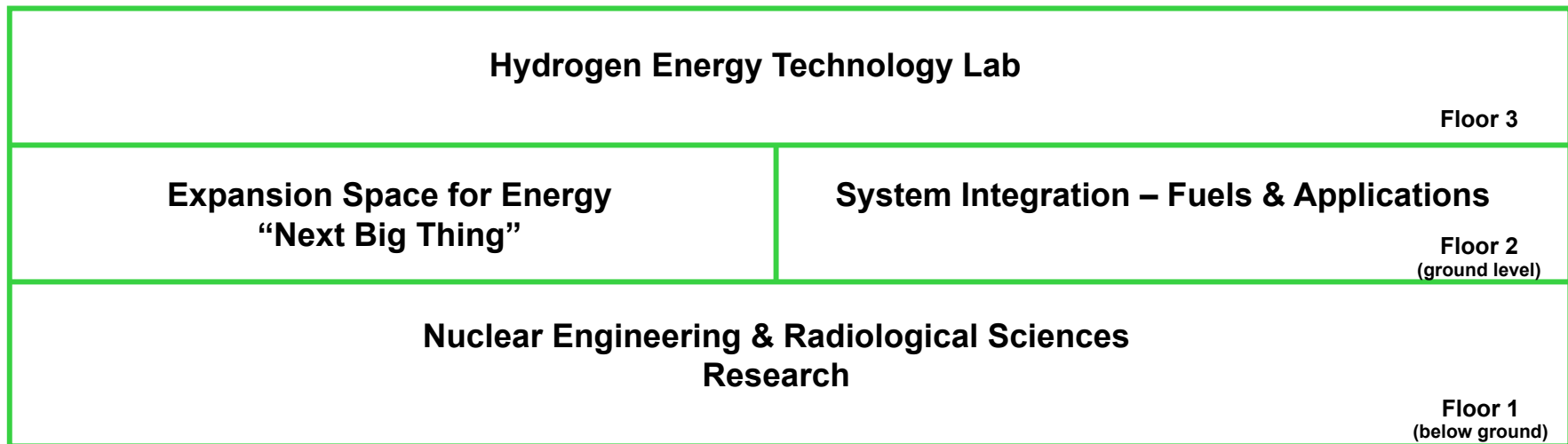


The Phoenix Memorial Energy Institute - A focusing agent for the University of Michigan energy initiative.

Phoenix Memorial Lab: Infrastructure Upgrade

A Home for Michigan's Energy Future

\$10M committed to upgrade Phoenix building.



Possible Future Steps

- Renovation of Phoenix Memorial Laboratory
- Repurposing of Industrial Technology Institute building
- Seeking state support of a major energy research laboratory (200,000 nsf) (closely coordinated with College of Engineering).





Industry will Benefit from working with the UM on the Energy Initiative

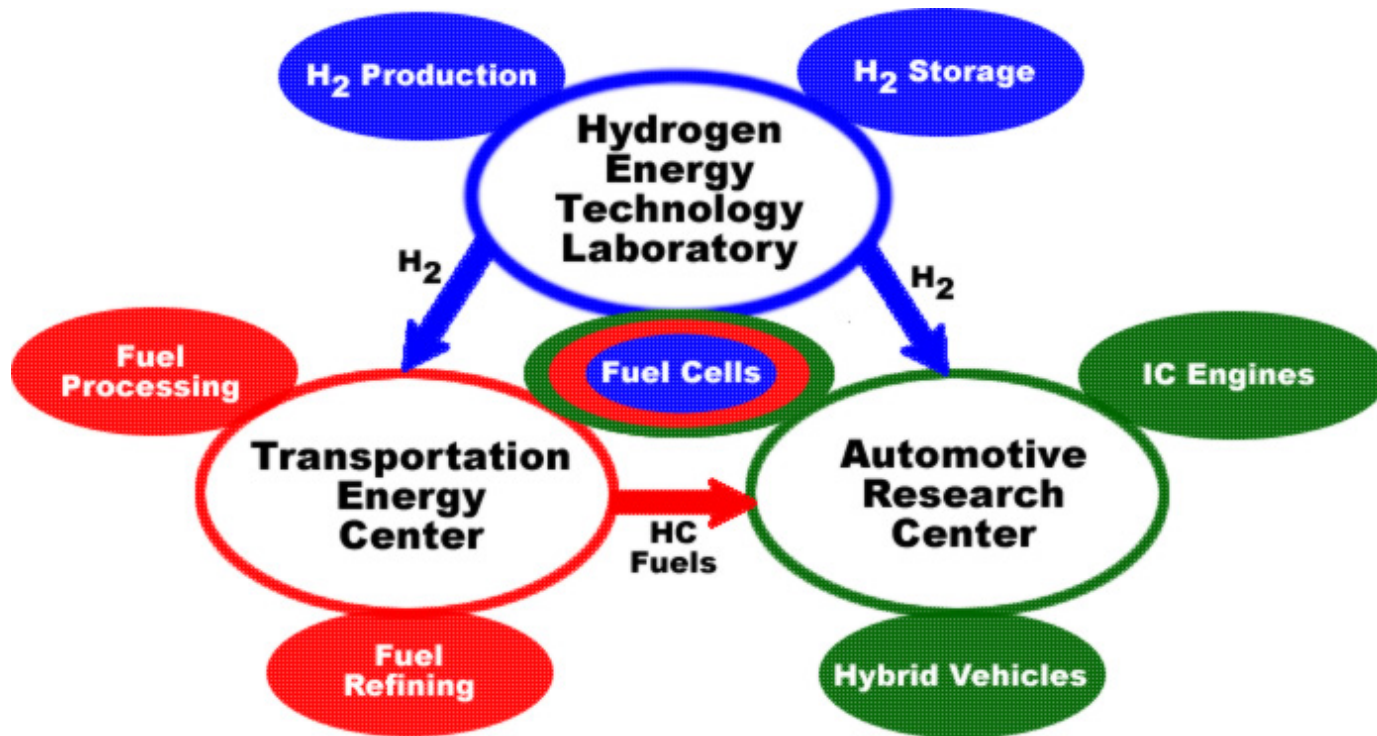
- Early awareness of developments in advanced energy research;
- Preferential access to students;
- Preferential access to distance learning and educational programs;
- Take part in neutral forum for suppliers and end-users;
- Highest-priority access to Center facilities and personnel;
- Advisory role in broader University advanced energy initiative.

Conclusion

Now is the time to establish the University of Michigan as an energy leader, specifically a research and education leader in the transition to hydrogen, other alternative fuels, and the propulsion systems they will power.

The UM has an opportunity to position itself as the intellectual leader for transportation energy systems critical to the economy of the Midwest.

Research on propulsion systems and fuels, hydrocarbon or otherwise, are a natural fit.



- **Transportation Energy Systems**

- Dennis Assanis, Director, Automotive Research Center

- **Fuels for the Future**

- Johannes Schwank, Director, Transportation Energy Center

- **Hydrogen Energy Technologies**

- Levi Thompson, Director, Hydrogen Energy Technology Laboratory

A final observation...

There is no issue more critical to the future of our society than its capacity to meet future energy needs without destroying Planet Earth, either through permanently damaging our environment through energy production or utilization, or triggering massive geopolitical instability over energy resources.

Hence research in these areas simply must be given a high priority at all levels (College, university, state, federal) and economic sectors (industry, NGOs, education).

Questions?

Backup Slides

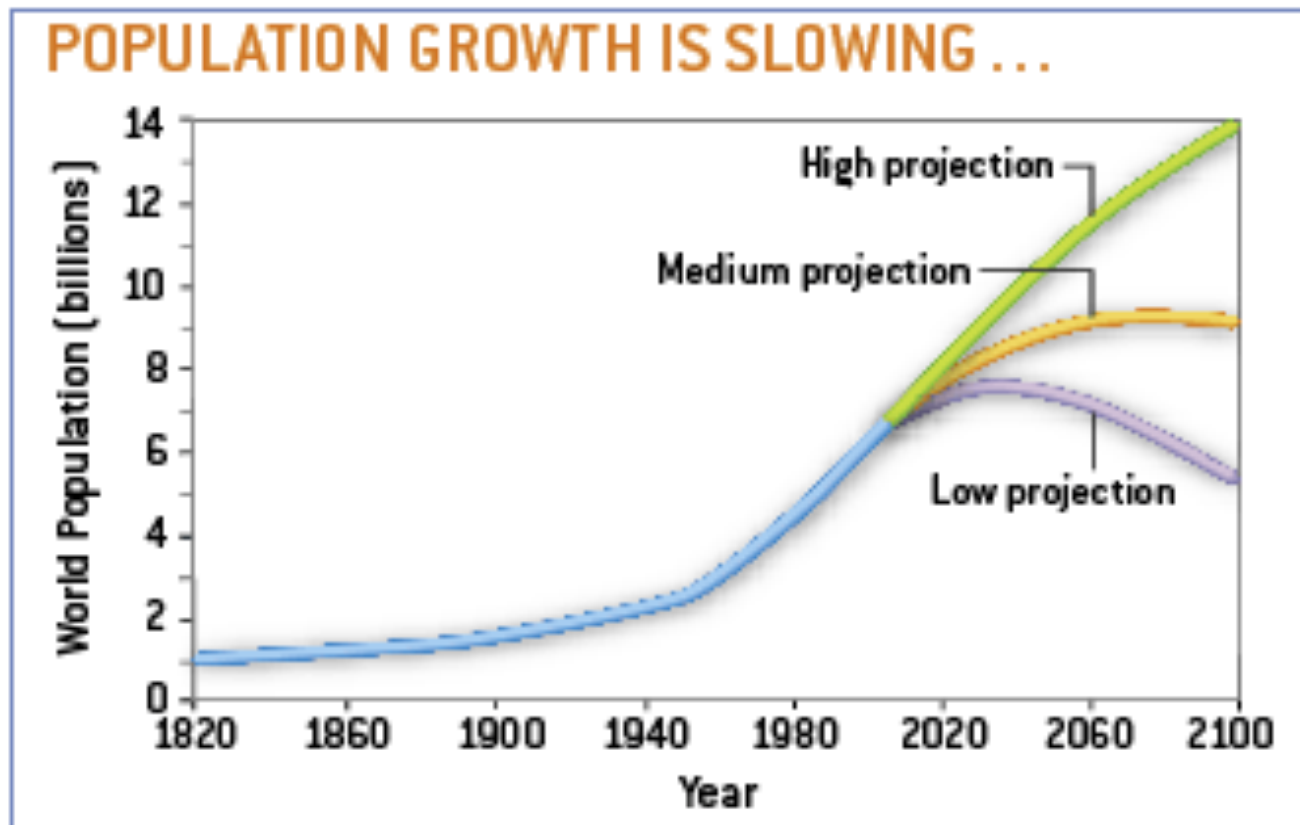
Michigan Expertise that Impacts the Automotive Industry

- Powertrain Systems
- Controls
- Microelectronics and Sensors
- Fuel Processing and Catalysis
- System Controls (engines, fuel cells, etc)
- Hydrogen Storage
- Lightweight Materials
- Manufacturing Processes

The World Energy Challenge ...

A product of concurrent and connected trends

- **Population** – Growing to an estimated 9 billion by 2050

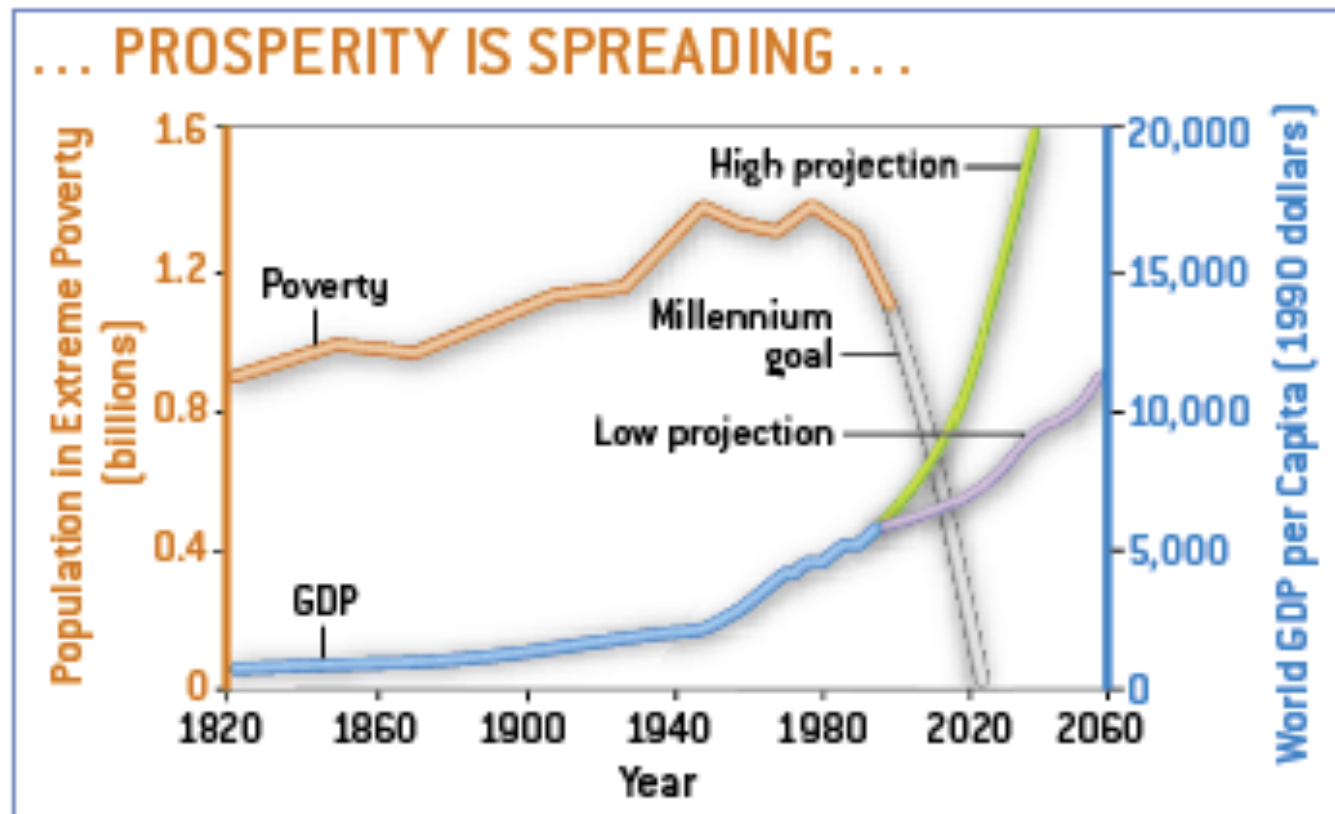


Ref: Scientific American special issue, *Crossroads for Planet Earth*, Sep 2005

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- **Economic** – Countries are getting wealthier. People will produce more and consume more, using more energy.

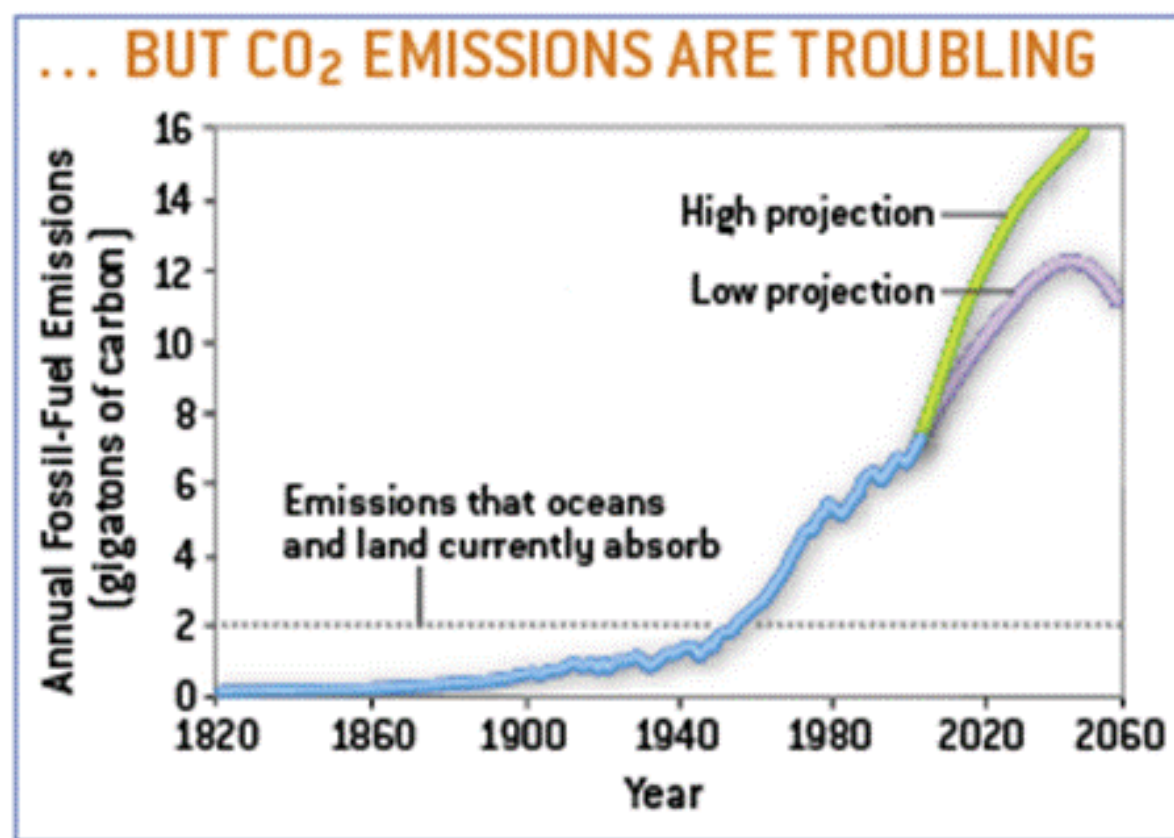


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- **Environmental** – Too much CO₂ for the earth to absorb, a consequence of hydrocarbon energy sources.



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- **Oil will run out.** World oil production will peak and then decline in the “near” future. Forecasted to occur sometime between 2015 and 2040.

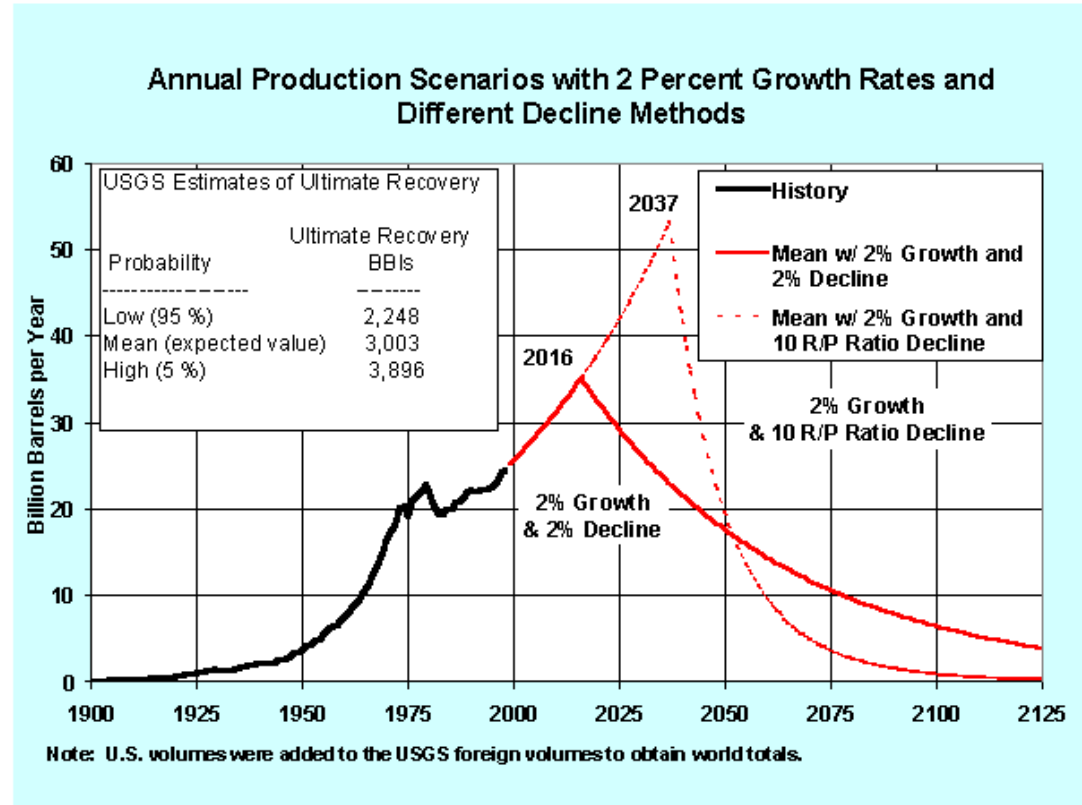


Figure A-1. Two EIA oil production scenarios based on expected ultimate world-recoverable oil of 3,003 billion barrels and a 2 percent annual world oil demand escalation

Ref: “Peaking of World Oil Production: Impacts, Mitigation, and Risk Management,” Robert L. Hirsch, SAIC, Roger Bezdek, MISI, Robert Wendling, MISI, Feb, 2005, DOE-funded study.