Energy Research at the University of Michigan

A Commitment to Michigan's Future

The World Is Flat A BRIEF HISTORY OF THE TWENTY-FIRST CENTURY Thomas L. Friedman



RISING ABOVE THE GATHERING Energizing and STORM

Employing America for a Brighter Economic Future





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A Strategic Roadmapping Exercise

James J. Duderstadt, Project Director The Millennium Project The University of Michigan September, 2005



The Michigan Roadmap





The Bad News

- Michigan unemployment leads the nation.
- Detroit has become the nation's poorest city.
- Michigan leads the nation in the out-migration of young adults seeking better opportunities elsewhere.
- Michigan's current workforce lacks the knowledge skills to compete in the global economy.
- Michigan is burdened with a tax system and public policies designed for a 1950s manufacturing economy rather than a 21st Century global, knowledge economy.
- Michigan's traditional manufacturing industries are unlikely to regain competitiveness. It is inevitable that we must evolve into a knowledge services economy!



What to do?

From California to North Carolina, Dublin to Bangalore, there is a growing recognition that economic prosperity and social well-being in a global knowledge economy require investment in knowledge resources.

That is, regions must create and sustain a highly educated and innovative workforce, supported through visionary public policies and public and private investments in world class education, cutting-edge technology, innovation, and an entrepreneurial spirit.

There is simply no alternative for Michigan's future.

Furthermore, there is no more critical technology to Michigan's future than energy.



Why energy research?

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.

But why is energy research important to Michigan?



- Over 500,000 Michigan jobs are dependent upon energy and related industries (e.g., transportation).
- The Great Lakes states produce and utilize 38% of the nation's electricity.
- The unsustainable nature of current energy technologies (e.g., fossil fuels) puts at great risk Michigan's existing industry and future economic prosperity–particularly the automobile industry.

Two Great Challenges



- Global production of petroleum and natural gas is likely to peak in the next two decades, leading to soaring prices that will inhibit use as a transportation or energy generation fuel.
- Growing concerns about the impact of hydrocarbon use on global climate will likely restrict even further conventional energy sources.



The World Energy Challenge ... A product of concurrent and connected trends

• Oil will run out. World oil production will peak and then decline in the "near" future. Forcasted 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.



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

Projected Date	Source of Projection	Background & Reference
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
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
		00
After 2020	CERA	Energy consultants 20
2025 or later	Shell	Major oil company ²¹
No visible peak	Lynch, M.C.	Energy economist ²²

Atmospheric CO₂: 50-year history



Source: Keeling and Whorf, data at cdiac.esd.ornl.gov/ndps/ndp001.html



Source: NASA GISS, at data.giss.nasa.gov/gistemp/graphs/



Arctic Ice Cap Change





Projected Global Warming Through 2100



2100 Projection: 6-meter sea level rise



Florida; h < 6 m in green region

Composite satellite image taken by Landsat Thematic Mapper, 30m resolution, supplied by the Earth Satellite Corporation. Contour analysis courtesy of Stephen Leatherman.

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 *

- 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
- * Examples from College of Engineering and School of Natural Resources and the Environment



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



Total Funding = \$35.1M

* 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)



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 Michigan Memorial Phoenix Project 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 Phoenix Project 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





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

Phoenix Memorial Energy Institute

- Basic energy sciences research
 - Hydrogen, materials, nanotechnology
- Energy systems research
 - Generation (fossil, nuclear renewable)
 - Conservation, environment, economics, policy
- Applied energy research
 - Transportation (ARC, TEC)
 - Industrial applications



Future Steps

- \$20 M Renovation of Phoenix Memorial Laboratory (ongoing)
- \$48 M Expansion of Solid State Laboratory into new Nanotechnology Laboratory (ongoing)
- Repurposing of Industrial Technology Institute building.
- Likely to seek eventual state support of a major energy research laboratory (200,000 nsf)

Conclusion



- There is no area of technology more important to the State of Michigan's economic future than alternative energy.
- The University of Michigan is making a very substantial commitment to building world-class research programs in this critical area that specifically target the needs and opportunities facing Michigan industry.
- By 2010 our goal is to have built the nation's leading programs in energy research and development across a broad range of energy science and technology.