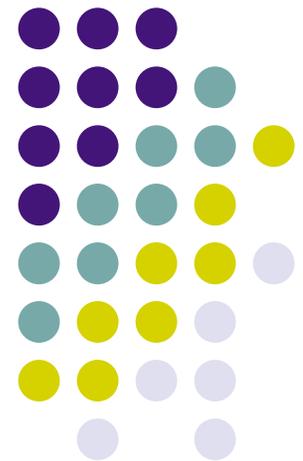


A National Energy Research Network

A Step Toward America's
Energy Sustainability





Today...

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.

Yet...



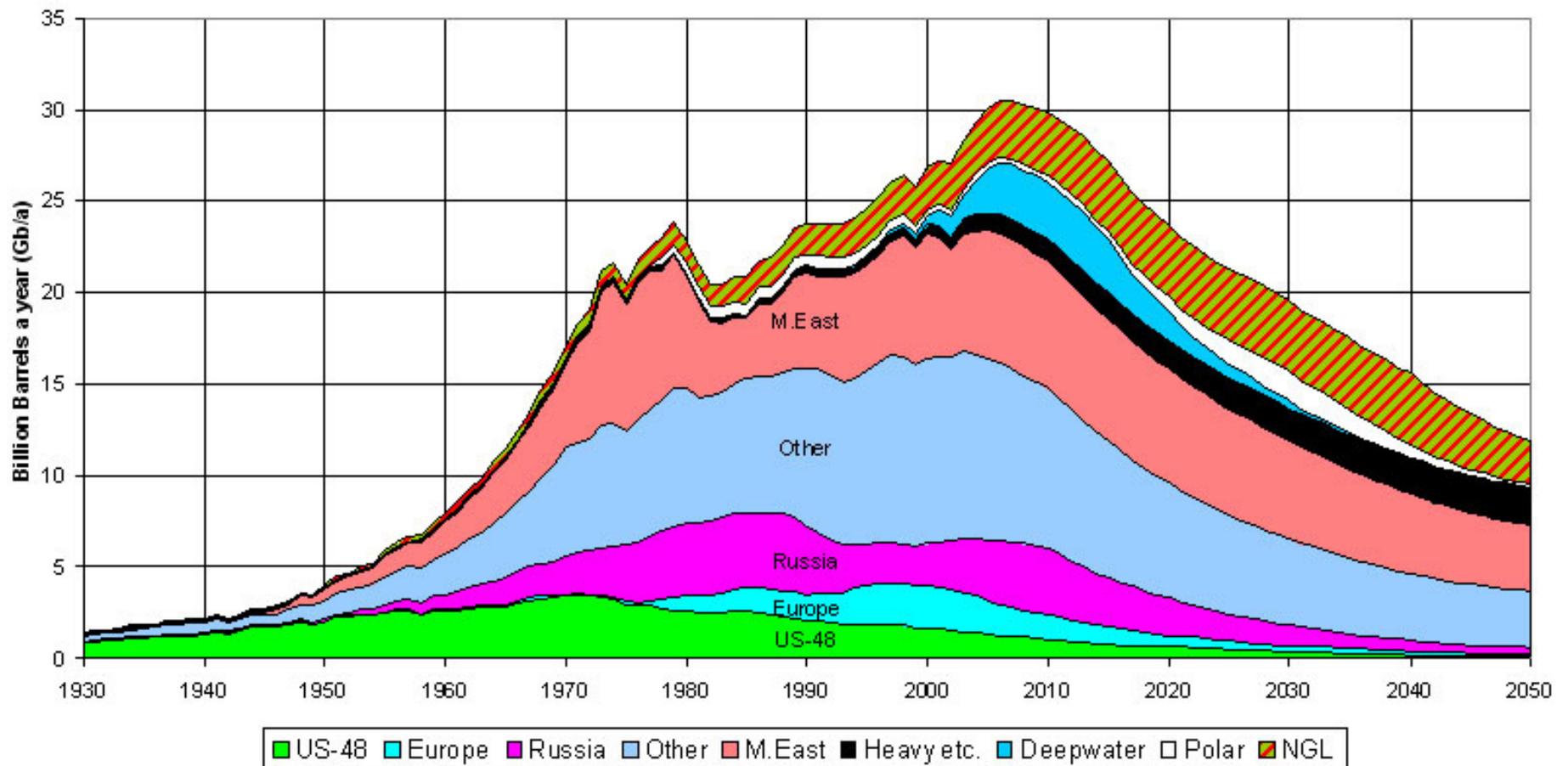
- Our current energy infrastructure, heavily dependent upon hydrocarbons, is unsustainable.
- Global oil and gas production is expected to peak within the next several decades.
- The burning of fossil fuels poses increasingly unacceptable risk to both humankind and the environment, particularly within the context of global climate change.
- The security of our nation is threatened by our reliance on foreign energy imports from politically unstable regions of the world.

Global Oil Production



- Recent analyses of petroleum production and known reserves suggest that global oil production could peak as early as the next decade (with gas production peaking a decade later).
- Rapidly increasing oil and gas demands from developing economies (China, India, Latin America) make this even more serious.
- DOE Report: "Without massive mitigation more than a decade before the fact, the problem will be pervasive and not be temporary."

OIL AND GAS LIQUIDS

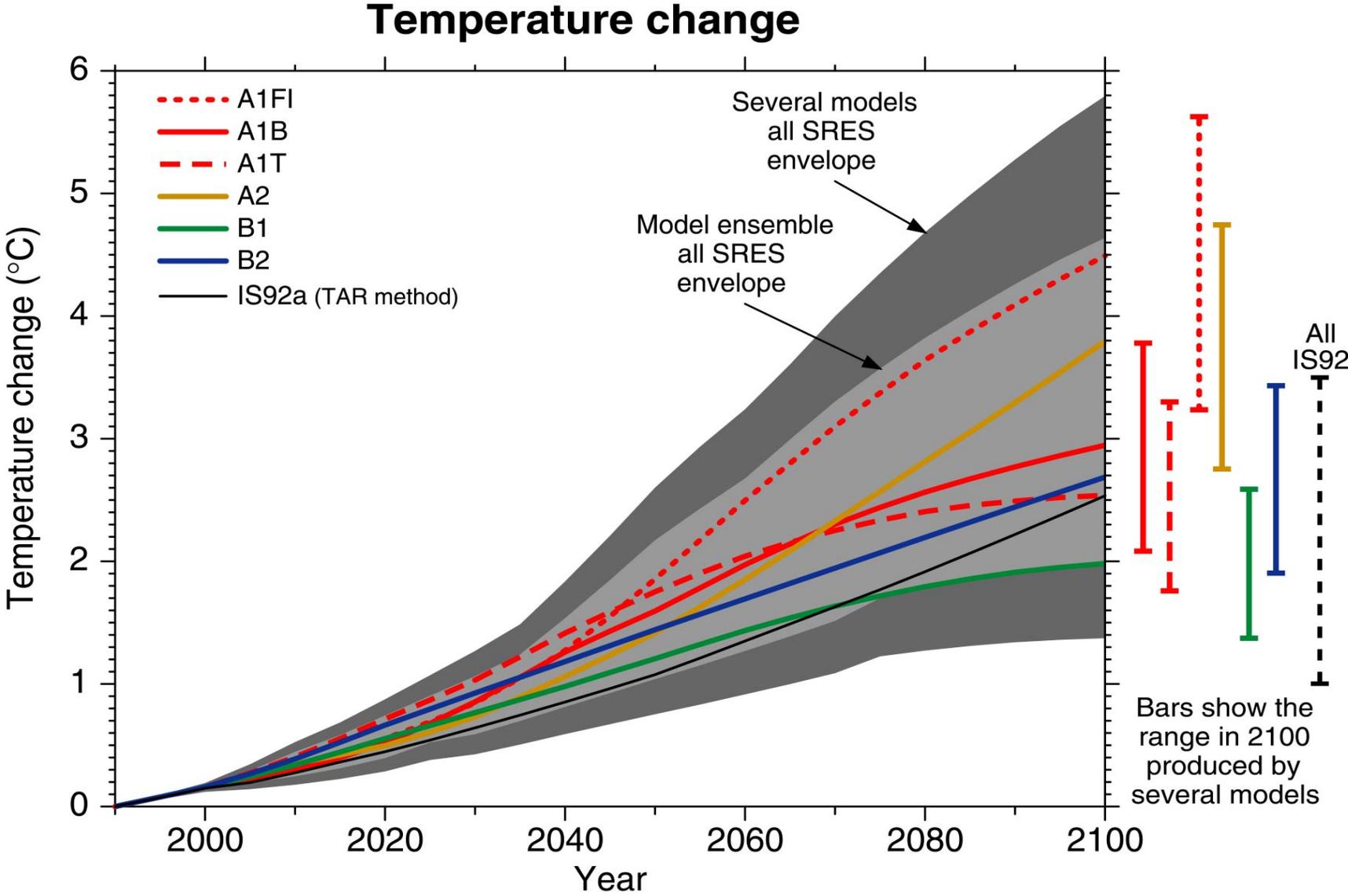


Global Climate Change

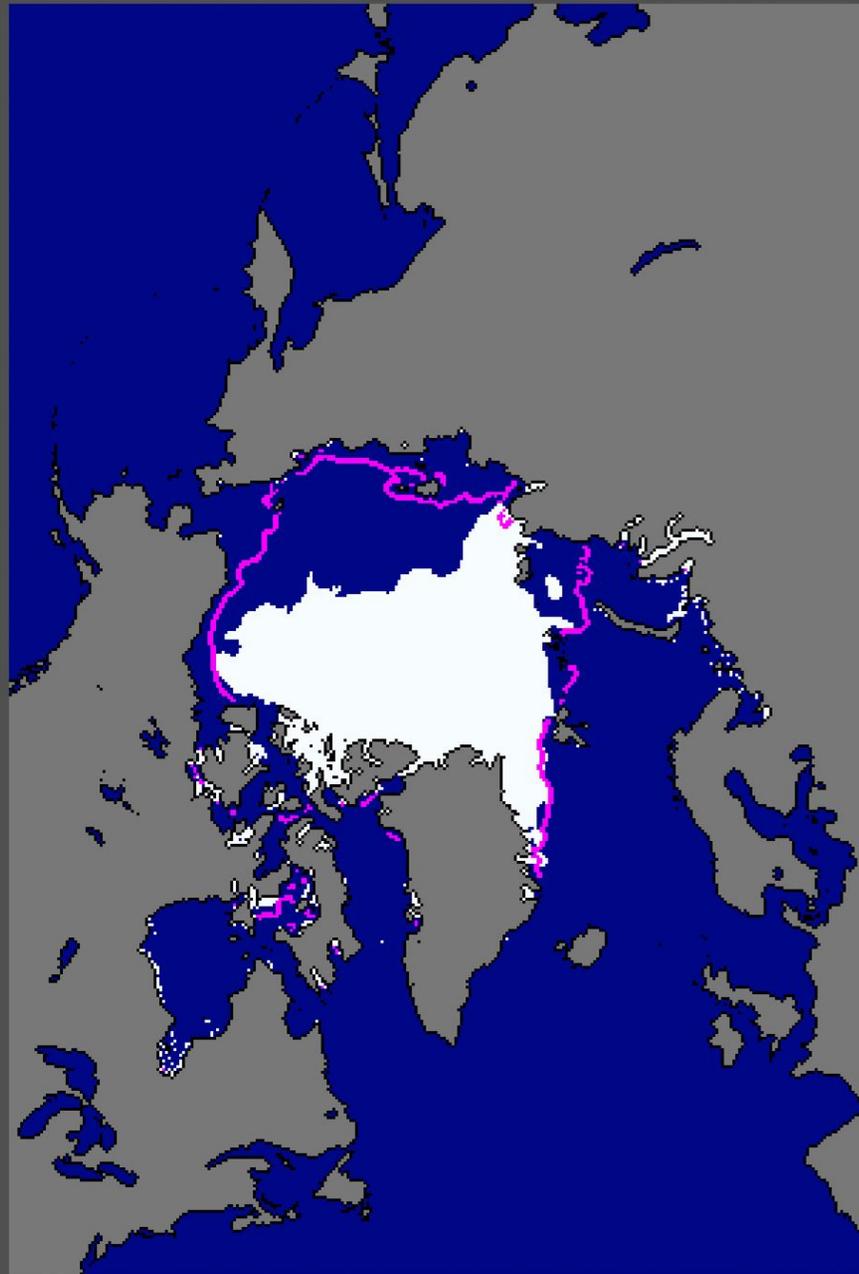


- IPCC: "Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities due primarily to fossil fuel use and land-use change".
- Evidence of global warming is now incontrovertible – increasing global surface and air temperatures, receding glaciers and polar ice caps, rising sea levels, and increasingly powerful weather disruptions confirm that unless the utilization of fossil fuels is sharply curtailed in the very near term, humankind could be seriously threatened.

Projected Global Warming Through 2100



Current Ice Extent
08/21/2007



National Snow and Ice Data Center, Boulder, CO

median
ice edge

Total extent = 4.9 million sq km

Complexity



- Large scale deployment of sustainable energy technologies will involve not only advanced scientific research and the development of new technologies...
- But careful attention to complex social, economic, legal, political, behavioral, consumer, and market issues...
- All characterized by complex regional, national, and international relationships.
- Little wonder that "The energy crisis is like the weather; everybody complains about it, but nobody does anything about it!"

The scale of the energy challenge



- Growing global energy demand will require over \$16 trillion in capital investments over next two decades.
- To meet the projected growth in electricity demand, the world will need to bring online a new 1,000 Mwe powerplant every day.
- Clearly this requires a federal R&D effort comparable in scale to the Manhattan Project or the Apollo program.

DOE SEAB Study



- "America cannot retain its freedom, way of life, or standard of living in the 21st century without secure, sustainable, clean, and affordable sources of energy.
- America can meet its energy needs if and only if the nation commits to a strong and sustained investment in research, and if we translate advancing scientific knowledge into practice.
- The nation must embark on a major research initiative to address the grand challenge associated with the production, storage, distribution, and conservation of energy as an urgent national priority."

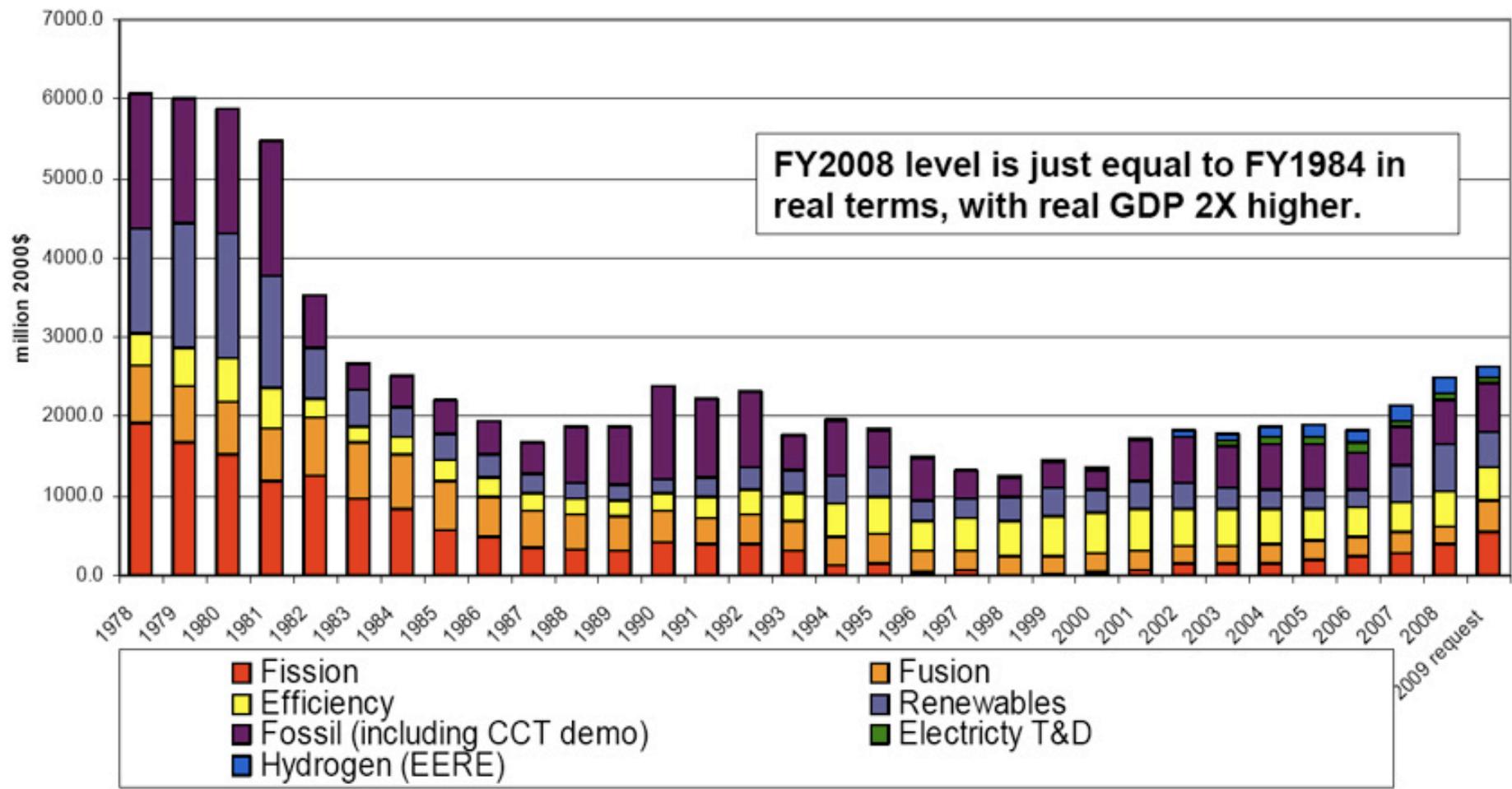
So what have we done thus far?



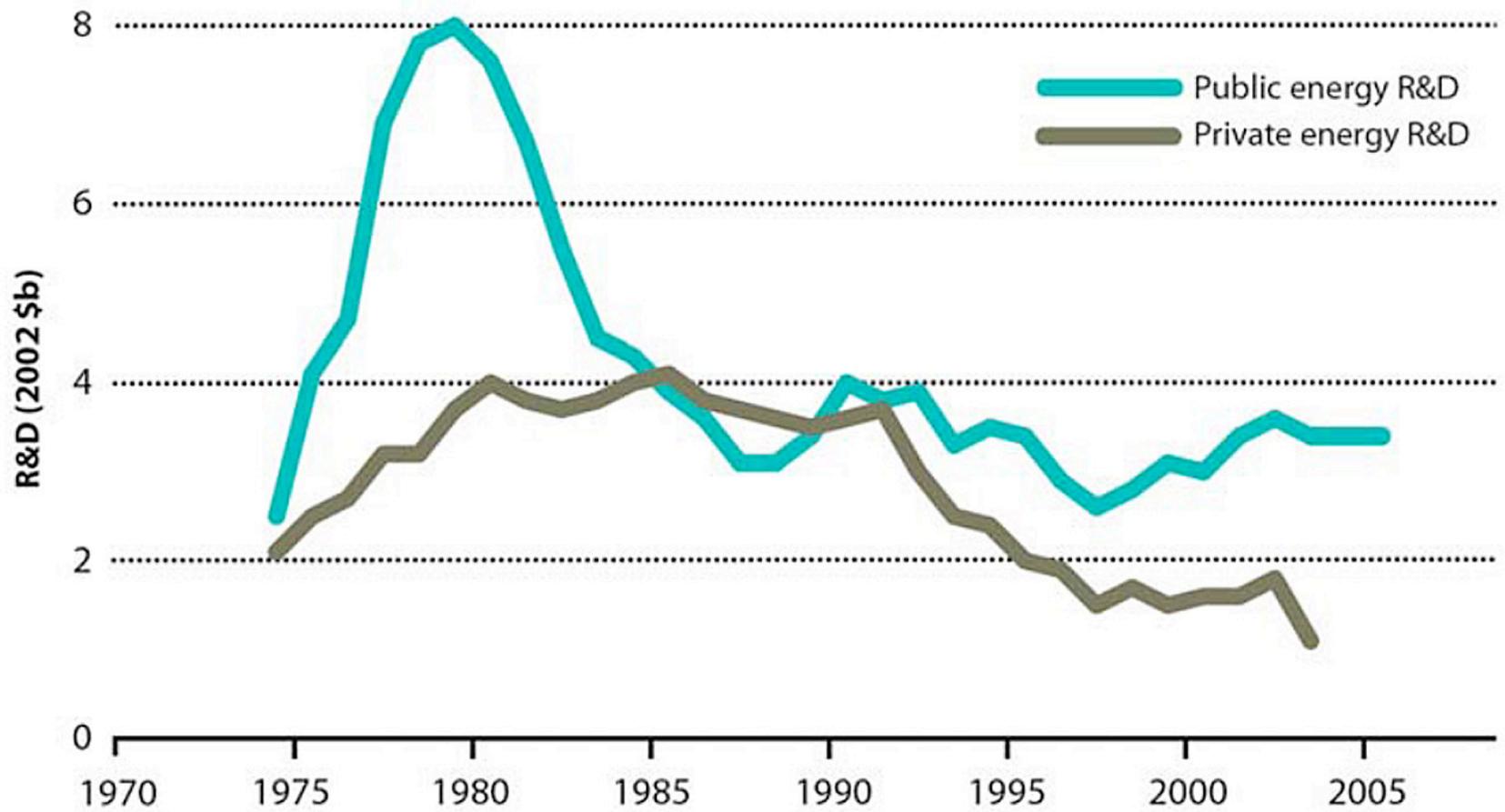
- Over the past two decades, energy research has actually been sharply curtailed by the federal government (75% decrease), the electrical utility industry (50%), and the domestic automobile industry (50%).
- Today the federal government effort in energy R&D is less than 20% of its level during the 1980s.
- Despite the fact that a major increase in energy research was intended to be a major component of both the America Innovation Initiative and the America COMPETES Act, this has largely been ignored by the current administration.

US federal energy-technology RD&D, 1978-2009

U.S. DOE Energy RD&D Spending
FY1978-FY2009 Request

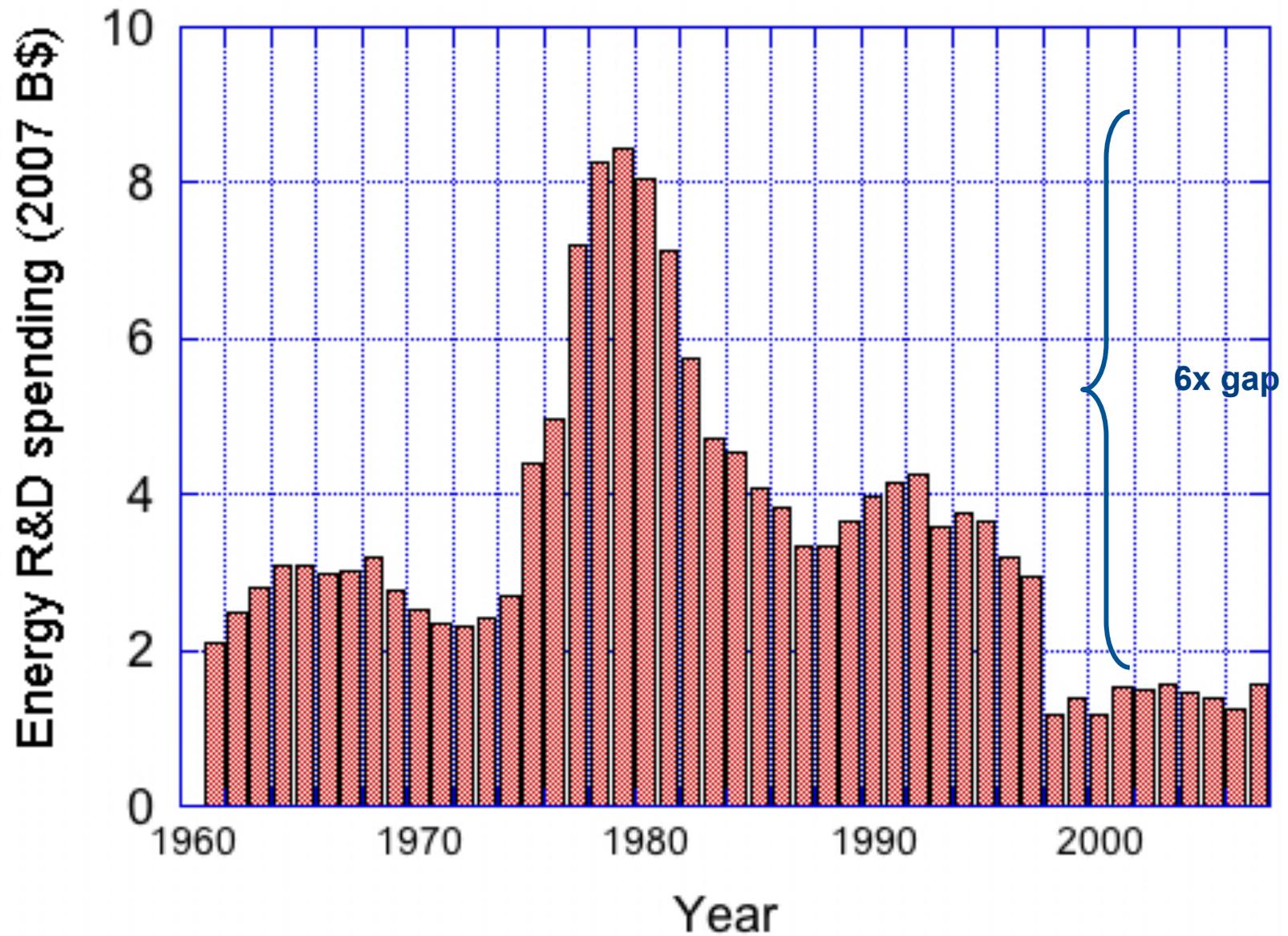


Kelly Gallagher, Harvard U, 2-14-08



Declining energy R&D by economic sector (Kammen, 2005)

Trends in US Federal R&D Spending for Energy



How much energy R&D?



- Federal R&D efforts
 - NASA: \$12 B/y
 - NIH: \$31 B/y
 - DOD: \$84 B/y
 - DOE energy: \$2 B/y
- Sector size
 - Health care: \$2.3 trillion
 - Defense: \$0.7 trillion
 - Energy: \$1.4 trillion

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 - Energy: \$1.4 trillion
- These comparisons suggest federal energy R&D should be in the range of \$30 to \$40 billion/year, at least an order of magnitude higher than current levels of federal investment!

Existing R&D paradigms are not up to the task...



- DOE SAEB Study: "DOE has a historically poor reputation as badly managed, excessively fragmented, and politically unresponsive".
- "The organizational separation of DOE's basic and applied energy research programs makes the migration of basic research findings to applied research solutions difficult and undisciplined."
- DOE is characterized by stovepipe organizations that are all too frequently risk-adverse and parochial.
- DOE labs lack broader expertise in nontechnological issues (legal, business, public policy, social sciences, education)

New paradigms are required



- Appropriate to respond to the urgency, scale, and complexity of the energy challenge.
- Highly multidisciplinary, extending beyond technology
- Highly innovative commercialization approaches capable of rapid deployment into the marketplace
- Intimate partnerships among multiple players—federal agencies, research universities, established industry, entrepreneurs, and the investment community.
- A new research culture based on nonlinear flow and activity among a scientific discovery, technological innovation, entrepreneurial business development, and legal, social and political imperatives.

The “Next Energy” Plan



- Brookings Institution ("Blueprint for American Prosperity")
- Big 10, Pac 10, (plus U. Colorado, U. New Mexico)
- Co-chairs: Gordon Gee (OSU); Michael Crow (ASU)
- VPRs: UM, OSU, UW, UI, ASU, CU, UCLA, UW
- Drafting Team (JJD chair):
 - Big 10: Energy faculty (UM, UW, UI, OSU, MSU,...)
 - Pac 10: VPs-Research (ASU,UW,UCLA,CU,UCSD)
 - Vetting by industry, DOE labs, federal policy wonks...
- Target Date for Brookings rollout: early December!

EXECUTIVE SUMMARY

Prepublication Copy

RISING ABOVE THE GATHERING STORM

*Energizing and
Employing America
for a Brighter
Economic Future*

NATIONAL ACADEMY OF SCIENCES,
NATIONAL ACADEMY OF ENGINEERING, AND
INSTITUTE OF MEDICINE

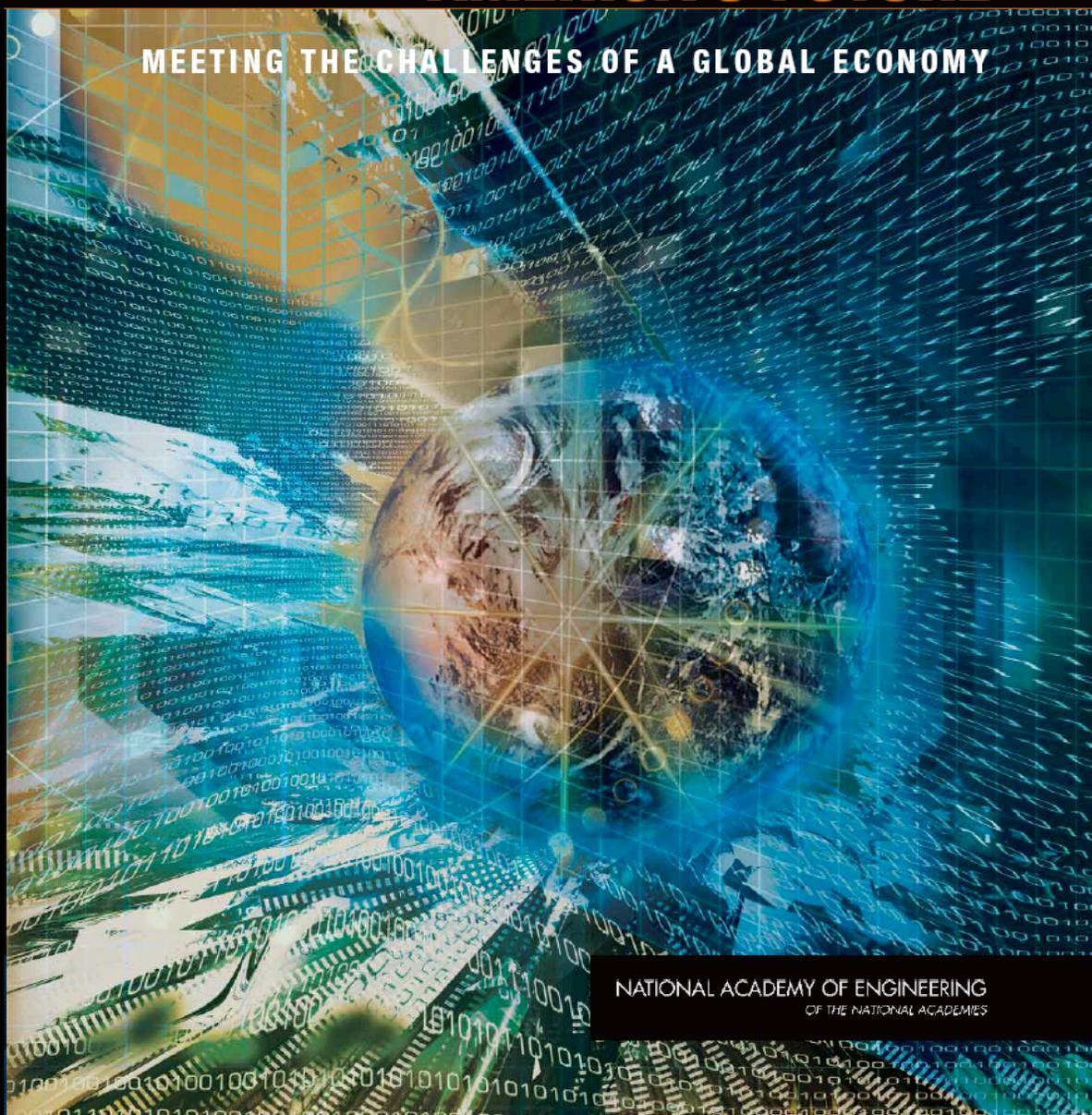
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OF THE NATIONAL ACADEMIES

ENGINEERING RESEARCH AND AMERICA'S FUTURE

MEETING THE CHALLENGES OF A GLOBAL ECONOMY

NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES

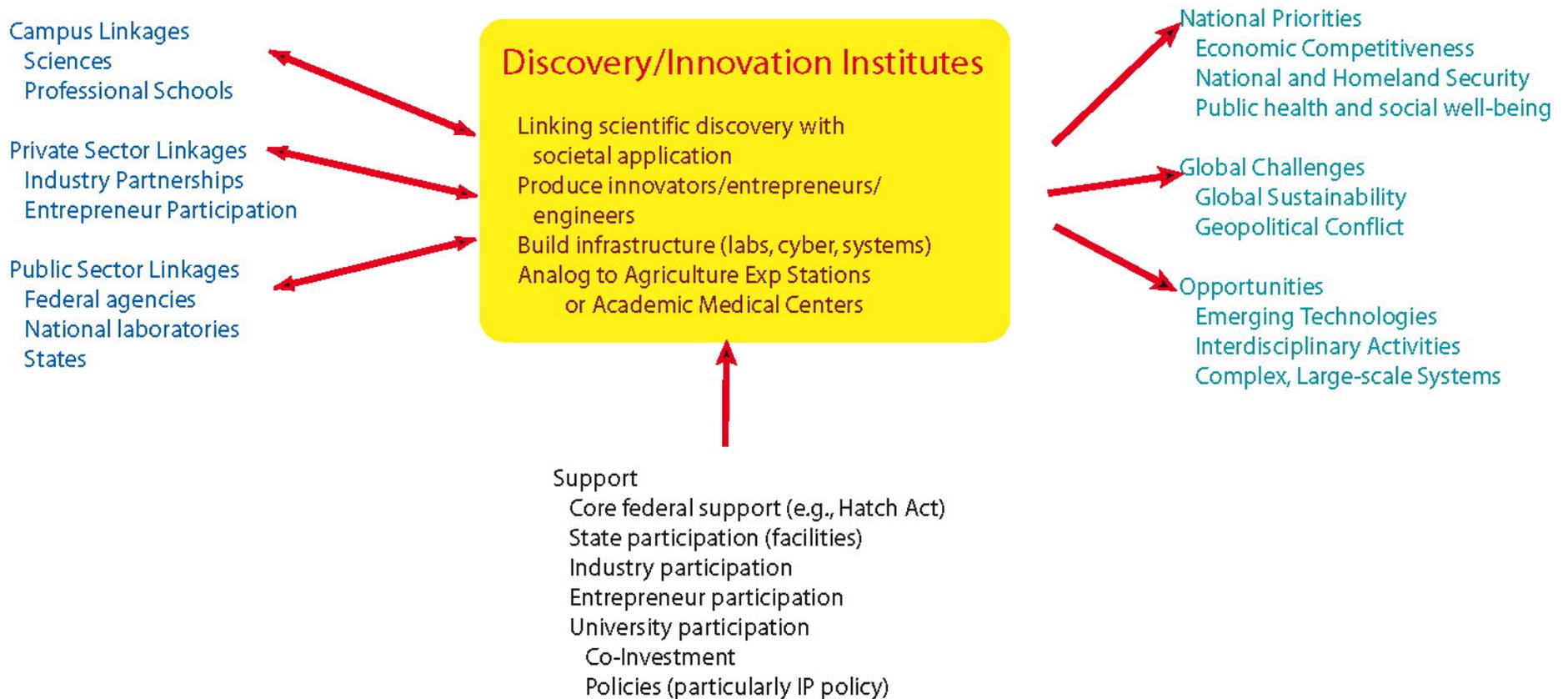


Discovery Innovation Institutes



To address the challenge of maintaining the nation's leadership in technological innovation, the committee is convinced that a bold, transformative initiative is required.

To this end, we recommend the establishment of multidisciplinary Discovery-Innovation Institutes on university campuses designed to perform the engineering research that links fundamental scientific discovery with the technological innovation to create the products, processes, and services needed by society.



Discovery-Innovation Institutes



- Although **primarily associated with engineering schools**, DIIs would partner with other professional schools (e.g., business, medicine, law) and academic disciplines.
- To ensure the necessary transformative impact, the DII program should be **funded at levels comparable to other major federal initiatives such as biomedicine and manned spaceflight**, e.g., building to several billion dollars per year and distributed broadly through an interagency competitive grants program.



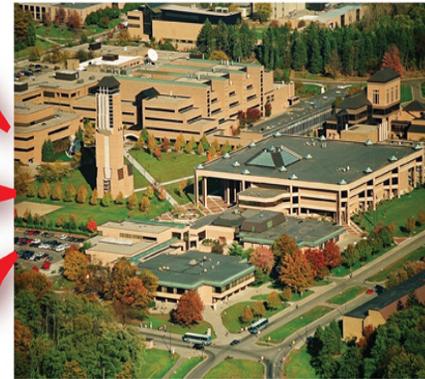
Corporate R&D Laboratory (Pfizer)



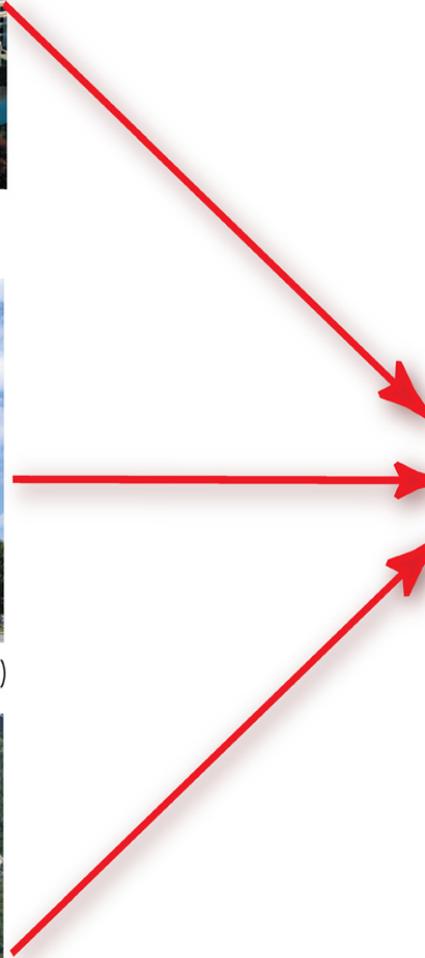
Agricultural Extension (Michigan State)



Academic Medical Center (Michigan)



Discovery Innovation Institute???



Discovery-Innovation Institutes



- Like agricultural experiment stations, they would be responsive to societal priorities.
- Like academic medical centers they would bring together research, education, and practice.
- Like CR&D laboratories, they would link fundamental discoveries with the engineering research necessary to yield innovative products, services, and systems, but while also educating the next generation technical workforce.



The Goal

- Augment the existing national laboratory and industrial R&D infrastructure with new research paradigms that
- Provide a broader intellectual span including the social and behavioral sciences along with professional disciplines such as business, law, and public policy;
- Add more robust educational efforts capable of producing the human capital required by the emerging energy sector; and
- Address the particular needs and opportunities characterizing different regions of the country.

The Proposal



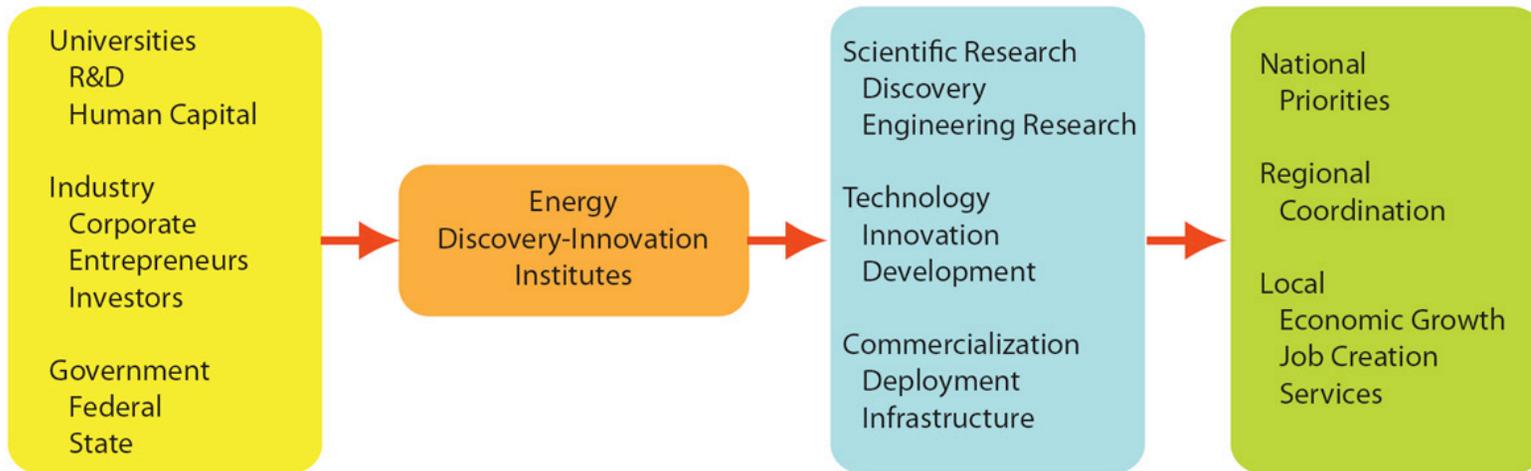
- A National Energy Research Network:
- Create a highly coordinated national network of discovery-innovation institutes focused on energy research.
- Each located adjacent to a major research university.
- Organized into clusters addressing the particular challenges faced by various regions of the nation.

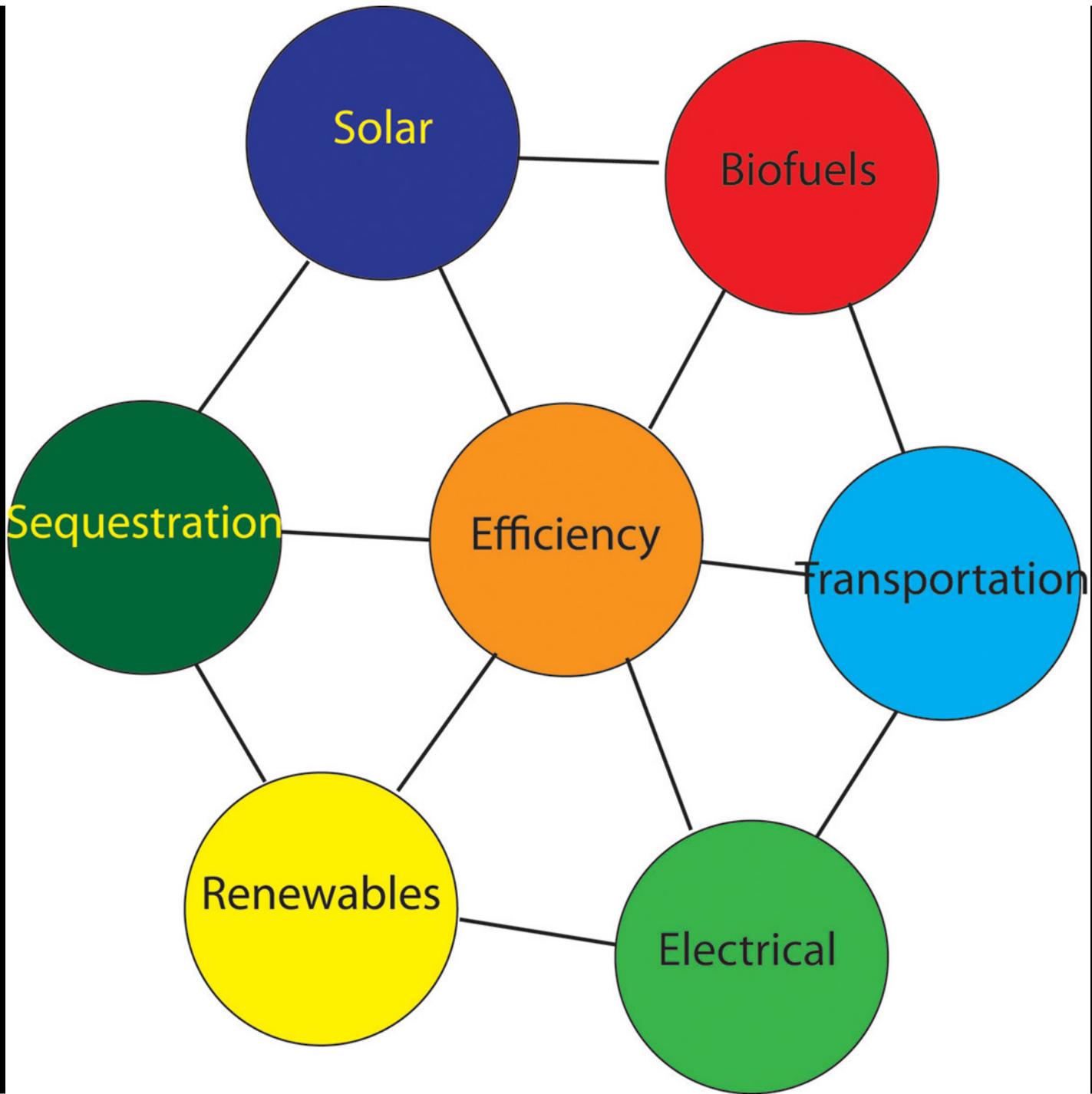


More specifically

- Each discovery-innovation institute would be created as a FFRDC with core support from multiple federal agencies growing to \$200 M/y.
- With additional support from state governments, industry, investment community, foundation, and university sources.
- Organized into regional clusters managed by a university consortium with strong participation from the private sector.
- And highly integrated using rapidly evolving cyberinfrastructure and virtual organizational structures (similar to the Blue Waters petascale effort).

Energy Discovery- Innovation Institutes

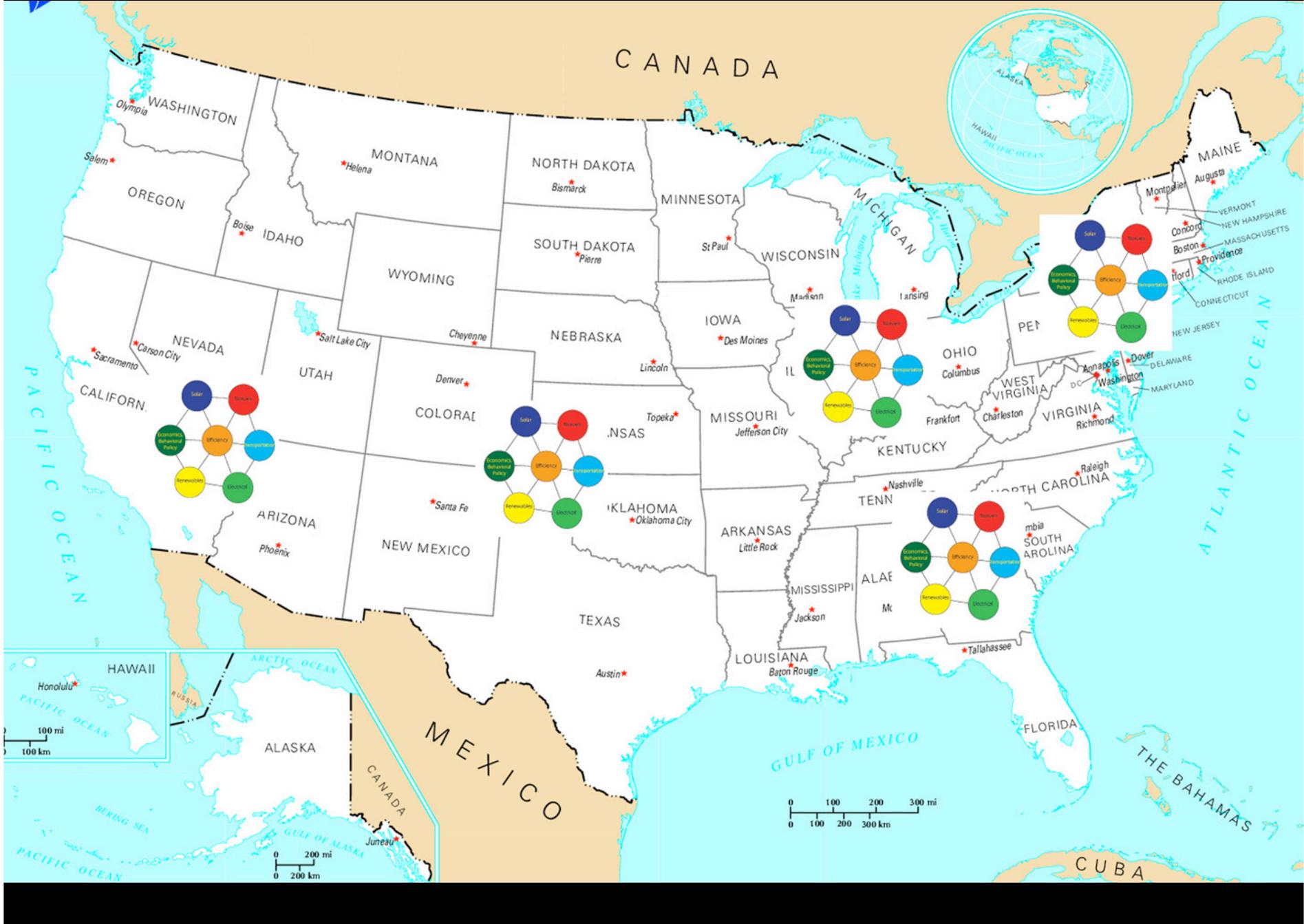




Regional characteristics



- Great Lakes: Energy-intensive economy (manufacturing, agriculture, transportation); large urban populations; few national laboratories; major research universities
- Mountain West: fragile ecosystems; highly dispersed populations; significant primary energy sources; strong potential for solar and wind energy; numerous national laboratories
- Northeast, Southeast, Midwest, ...



CANADA



WASHINGTON Olympia
OREGON Salem
IDAHO Boise
MONTANA Helena
NORTH DAKOTA Bismarck
MINNESOTA St Paul
SOUTH DAKOTA Pierre
WISCONSIN Madison
MICHIGAN Lansing
IOWA Des Moines
NEBRASKA Lincoln
NEBRASKA Topeka
MISSOURI Jefferson City
ILLINOIS Springfield
OHIO Columbus
PENNSYLVANIA Harrisburg
WEST VIRGINIA Charleston
VIRGINIA Richmond
TENN. Nashville
SOUTH CAROLINA Columbia
MISSISSIPPI Jackson
LOUISIANA Baton Rouge
ARKANSAS Little Rock
KENTUCKY Frankfort
MISSOURI Jefferson City
MISSISSIPPI Jackson
ALABAMA Montgomery
FLORIDA Tallahassee
NEW YORK Albany
MAINE Augusta
VERMONT Montpelier
NEW HAMPSHIRE Concord
MASSACHUSETTS Boston
RHODE ISLAND Providence
CONNECTICUT Hartford
NEW JERSEY Trenton
DELAWARE Dover
MARYLAND Annapolis
DC Washington

CALIFORNIA Sacramento
NEVADA Carson City
UTAH Salt Lake City
COLORADO Denver
NEW MEXICO Santa Fe
ARIZONA Phoenix
TEXAS Austin

PACIFIC OCEAN

ATLANTIC OCEAN

GULF OF MEXICO

THE BAHAMAS

CUBA



0 200 mi
0 200 km

0 100 200 300 mi
0 100 200 300 km



In summary...

- Today an increasingly economically fragile, environmentally damaging, and geopolitically vulnerable energy infrastructure has put at great risk not only America's economic prosperity and national security but even the very future of humankind on Earth.
- New energy technologies must be developed and deployed that are not only sustainable for the long term but are also characterized by acceptable environmental impact as well as legal and social infrastructures.
- This will require not only a massive federal R&D effort an order of magnitude larger than the current level but also radically different research paradigms.



An Interesting Antecedent

- The Hatch Act of 1887 responded to the challenges of modernizing American agriculture and industry by creating a network of university-based agricultural and engineering experiment stations.
- These involved a partnership involving land-grant universities, business, state, and federal government.
- These experiment stations were instrumental in developing and deploying the technologies necessary to transform the United States into the modern industrial nation that has dominated the 20th century while stimulating local economic growth.

NREN: A response to the energy challenges of the 21st Century.



- The proposed National Energy Research Network of regional energy discovery-innovation institutes is remarkably similar to experiment stations established by the Hatch Act of 188y, both in spirit and in structure.
- These would involve a partnership among research universities, business and industry, entrepreneurs and investors, and federal, state, and local government.
- The energy discovery-innovation institutes would conduct the research, development, and commercialization of new energy technologies necessary to build a sustainable national energy infrastructure for the 21st century while stimulating strong regional economic growth and job creation.

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Energy Discovery- Innovation Institutes

