# Is the Energy Race our new "Sputnik" Moment?

National Press Club

Washington, D.C.

29 November, 2010

October 4, 1957, the Soviet Union placed a 184 pound satellite into orbit.

On November 13, 1957, President Eisenhower responds:


"The Soviet Union now has – in the combined category of scientists and engineers – a greater number than the United States. And it is producing graduates in these fields at a much faster rate …

This trend is disturbing. Indeed, according to my scientific advisers, this is for the American people the most critical problem of all. My scientific advisers place this problem above all other immediate tasks of producing missiles, of developing new techniques in the Armed Services. We need scientists in the ten years ahead…"

1) Innovation adds to the wealth of society

2) Science and technology R&D lie at the heart of innovation

3) Leadership in innovation cannot be taken for granted.

# Innovation is key to prosperity and progress

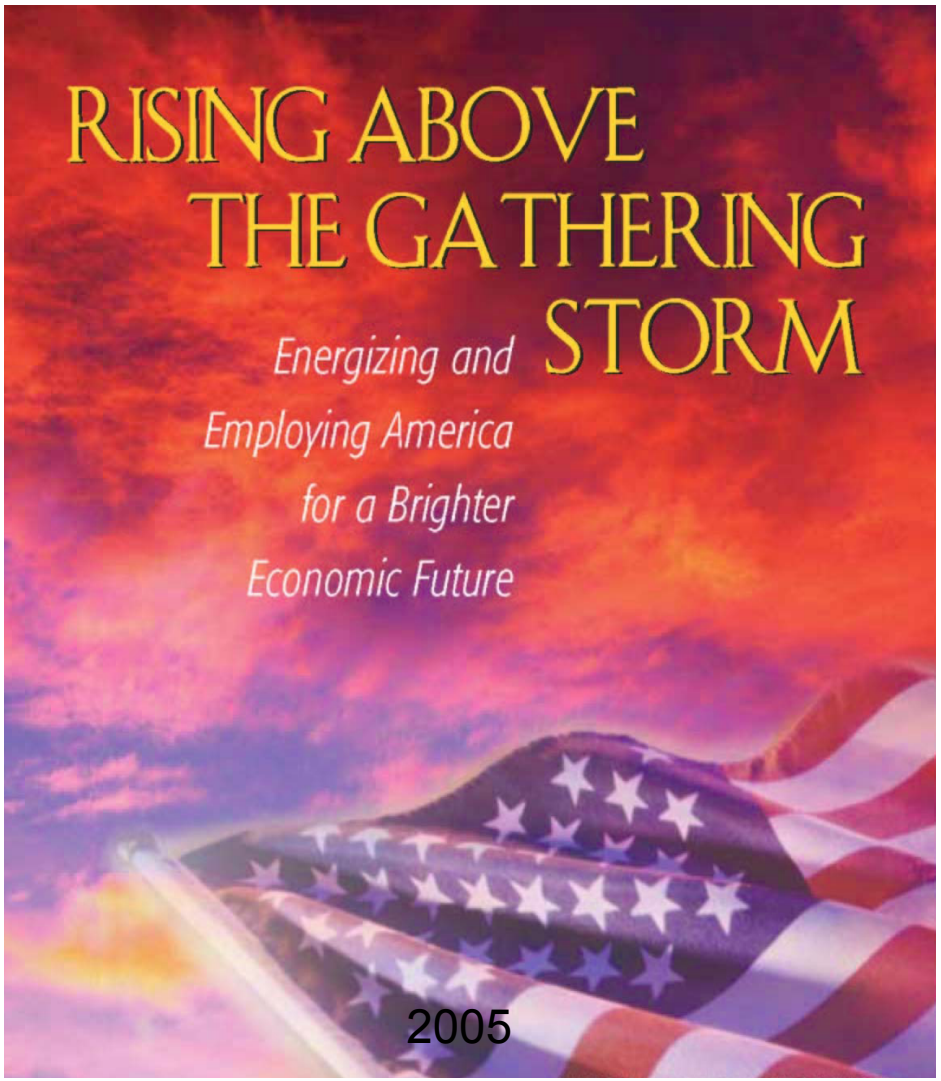
Robert Solow won a Nobel Prize for his work showing that **increases in productivity were due to technology development.***

His work indicated that well over half of the growth in United States output per hour during the first half of the twentieth century could be attributed to advancements in knowledge, particularly technology.

Solow's analysis shows that the capital investments and the supply of labor will track each other in the long run. Additional wealth creation comes from technology advances.

* R.M. Solow, "*Technical Change and the Aggregate Production Function*", 1957; *Investment and Technical Progress", 1960.*

# Innovation is key to prosperity and progress




**National Academy of Sciences, Engineering, Institute of Medicine**

A Progress report, 2010

"Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5"

"In balance, it would appear that overall the United States long-term competitiveness outlook (read jobs) has further deteriorated since the publication of the Gathering Storm report five years ago."

# The U.S. innovation machine has been the greatest in the world

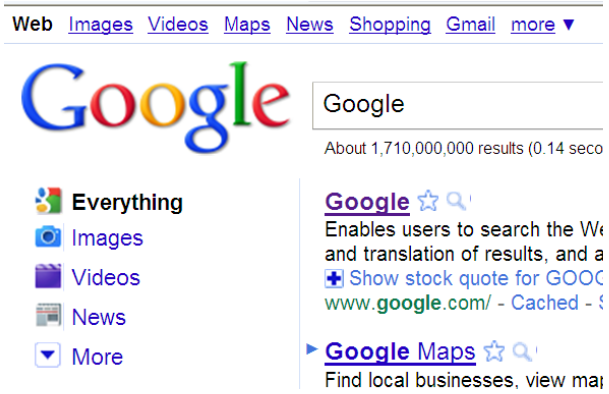
Model T Ford assembly line

First transistor

Integrated circuits

First airplane

Optical and satellite communication, GPS



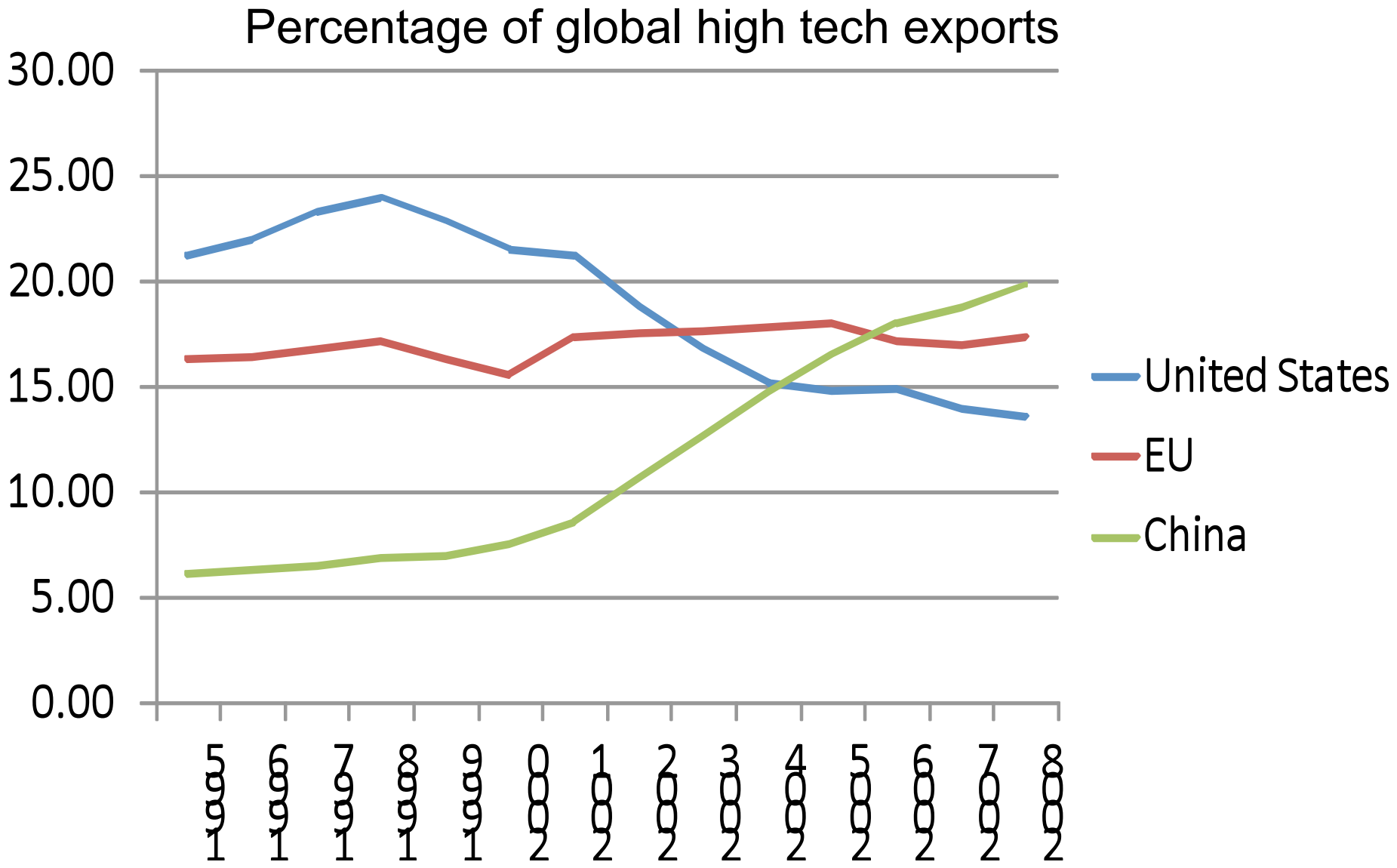

The Internet

1.7 Billion hits in 0.14 seconds

For over a century, America has led the world in innovation.

Today, that leadership is at risk.

# We are losing our *high-tech* manufacturing base




NSF Science and Engineering Indicators 2010

"We should see scientific and technological innovation as an important pillar and make greater effort to develop new industries of strategic importance. Science and technology is a powerful engine of economic growth . . . We will make China a country of innovation. . . We will accelerate the development of a low-carbon economy and green economy so as to gain an advantageous position in the international industrial competition."

Chinese Premier Wen Jiabao
World Economic Forum
September 10, 2009.

China's strategy in nurturing innovation:
use government policies to guide *the private sector*
into playing the leading role in R&D *

* From Xiaomei Tan, *Energy Policy* **38** 2916 (2010)

# U.S. Science and Technological Leadership at Risk

- In 2009, 51% of U.S. patents were awarded to non-U.S. companies. China has gone from 15th place to 5th in international patents.
- The World Economic Forum ranks the U.S. 48th in quality of mathematics and science education.
- China's Tsinghua and Peking Universities are the two largest suppliers of students who receive PhD's *- in the United States.*
- In less than 15 years, China has moved from 14th place to 2nd place in published research articles (behind the U.S.).
- Eight of the ten global companies with the largest R&D budgets have established R&D facilities in China, India or both. In a survey of global firms planning to build new R&D facilities, 77 percent say they will build in China or India.
- An American company recently opened the world's largest private solar R&D facility . . . in Xian, China.

Source: *Rising Above the Gathering Storm, Revisited*, 2010

# Other evidence of the Chinese innovation challenge

• China has installed the highest voltage and capacity, lowest loss HVDC (800kV) and HVAC (1,000 kV) lines, and plans an integrated HVDC/HVAC backbone.

• Broken ground on 30 nuclear reactors out of ~ 50 world-wide.

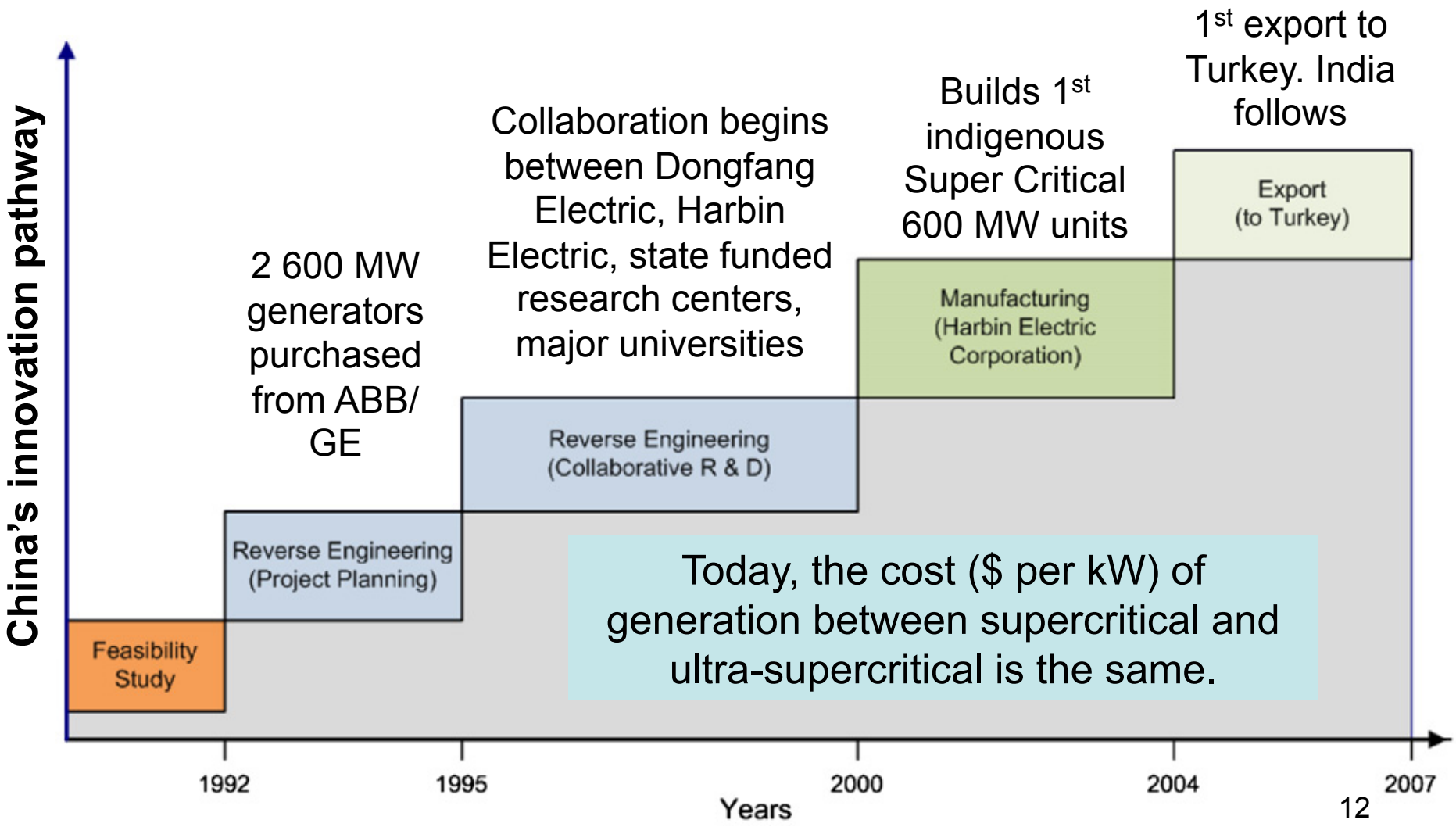
• Just surpassed the U.S. with the fastest super-computer in the world.

• Holds the record for the highest speed rail in the world (with 220 mph operational speed). 5612 miles of new high-speed rail is now under construction. (Japan - 1524 miles; France - 1163, U.S. – 0)

• China will achieve 18% (and may reach 20%) renewable energy by 2020 according to Zhang Xiaoqiang, vice-chairman of China's National Development and Reform Commission.

# The Development of Chinese Coal Power Plant Technology

"We shouldn't look at this project from a purely financial perspective. It represents the future." President of the China Huaneng Group



SUNTECH is the 3rd largest photo-voltaic producer in the world.

• Founded by Shi Zhengrong, an Australian citizen with a Ph.D degree in electrical engineering from the University of New South Wales. The CTO is Director of the Centre of Excellence for Advanced Silicon Photovoltaics and Photonics, University of New South Wales.

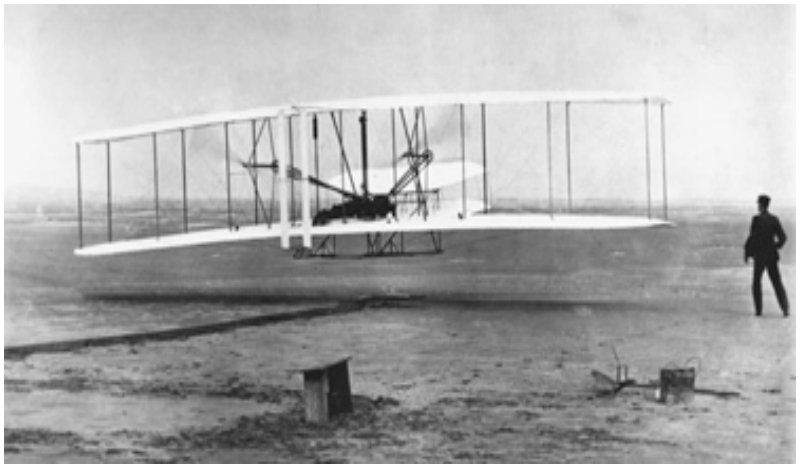
• Suntech imports the raw silicon crystal material from *U.S. suppliers*, manufactures the high-tech solar cells in a modern, automated facility in China, and is building assembly plants world wide, including the U.S.

• Suntech is focused on driving down manufacturing costs *and* set the conversion efficiency world record for a polycrystalline solar panel at 16.5%, as measured by the Fraunhofer Institute in Germany.

America ***still*** has the opportunity to lead the world in a new industrial revolution and secure our future prosperity, but time is running out.

Federal support of scientific R&D is critical to our economic competitiveness.

# Case Study – The U.S. Aviation Industry



The Wright Brothers achieved the first successful airplane flights in 1903.

But the U.S. quickly lost ground.

During World War I, most U.S. troops flew planes made in France.

In 1915, the U.S. government established the National Advisory Committee for Aeronautics (NASA's predecessor) to conduct cutting-edge research.

This research, and growing government demand, laid the groundwork for the take-off of the U.S. aviation industry.

American Energy Innovation Council

**Authors:**

| | |
|---|---|
| **Norm Augustine** | Former chairman and CEO, Lockheed Martin |
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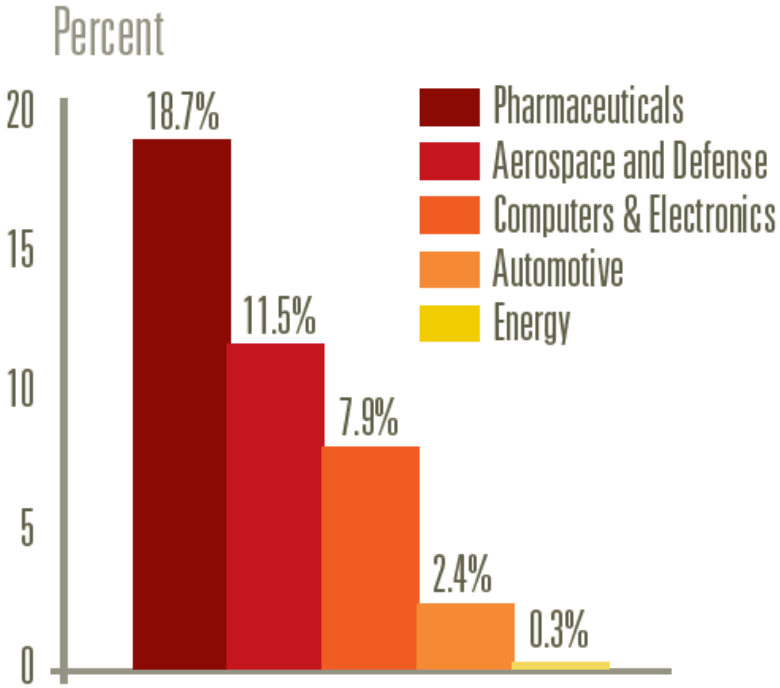
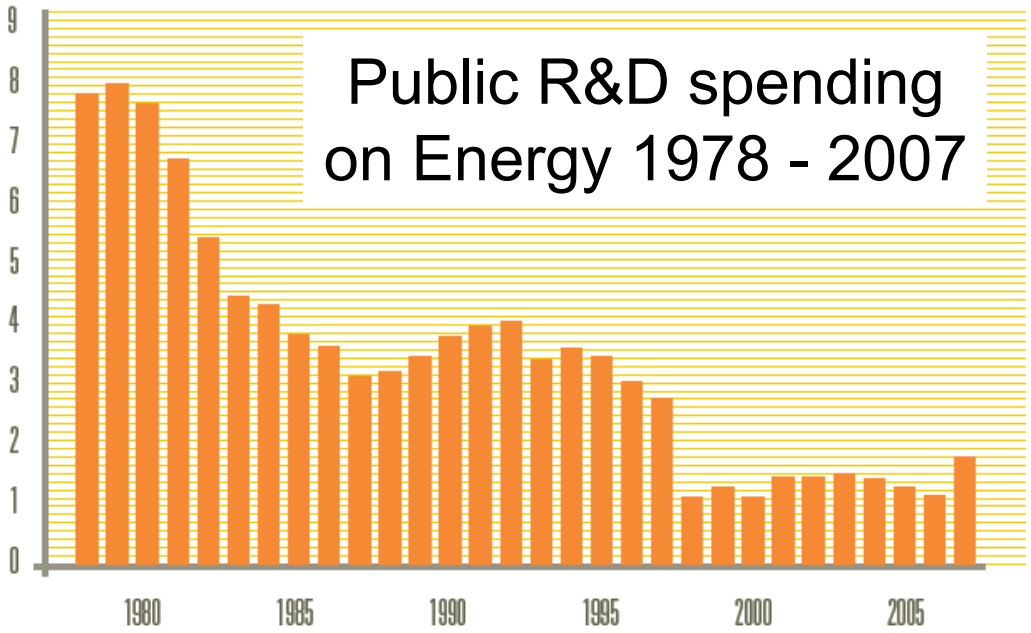
| **Bill Gates** | **C**hair and former CEO of Microsoft |
| **Chad Holliday** | Chair of B of A, former Chair and CEO of DuPont |
| **Jeff Immelt** | Chair and CEO of GE |
| **Tim Solso** | Chair and CEO, Cummins Inc. |

# A BUSINESS PLAN FOR AMERICA'S ENERGY FUTURE

Fraction of sales invested in R&D (private and public) In 2007




2010 Federal Budget is $3.6 Trillion. We are investing $5.1B in Energy R&D (0.14%)




**The Stimulus funding provided a huge down payment on additional R&D. Will we return to historical levels and trends?**

# "The government must play a key role in accelerating energy innovation" *

**1.Innovations in energy technology can generate significant, quantifiable public benefits …** These benefits include cleaner air and improved public health, enhanced national security and international diplomacy, reduced risk of dangerous climate change, and protection from energy price shocks and related economic disruptions. *Currently, these benefits are neither recognized nor rewarded by the free market.*

**2.The energy business requires investments of capital at a scale that is beyond the risk threshold of** most private-sector investors. This high level of risk … *exacerbates the historic dearth of investments in new ideas, creating a vicious cycle of status quo behavior.*

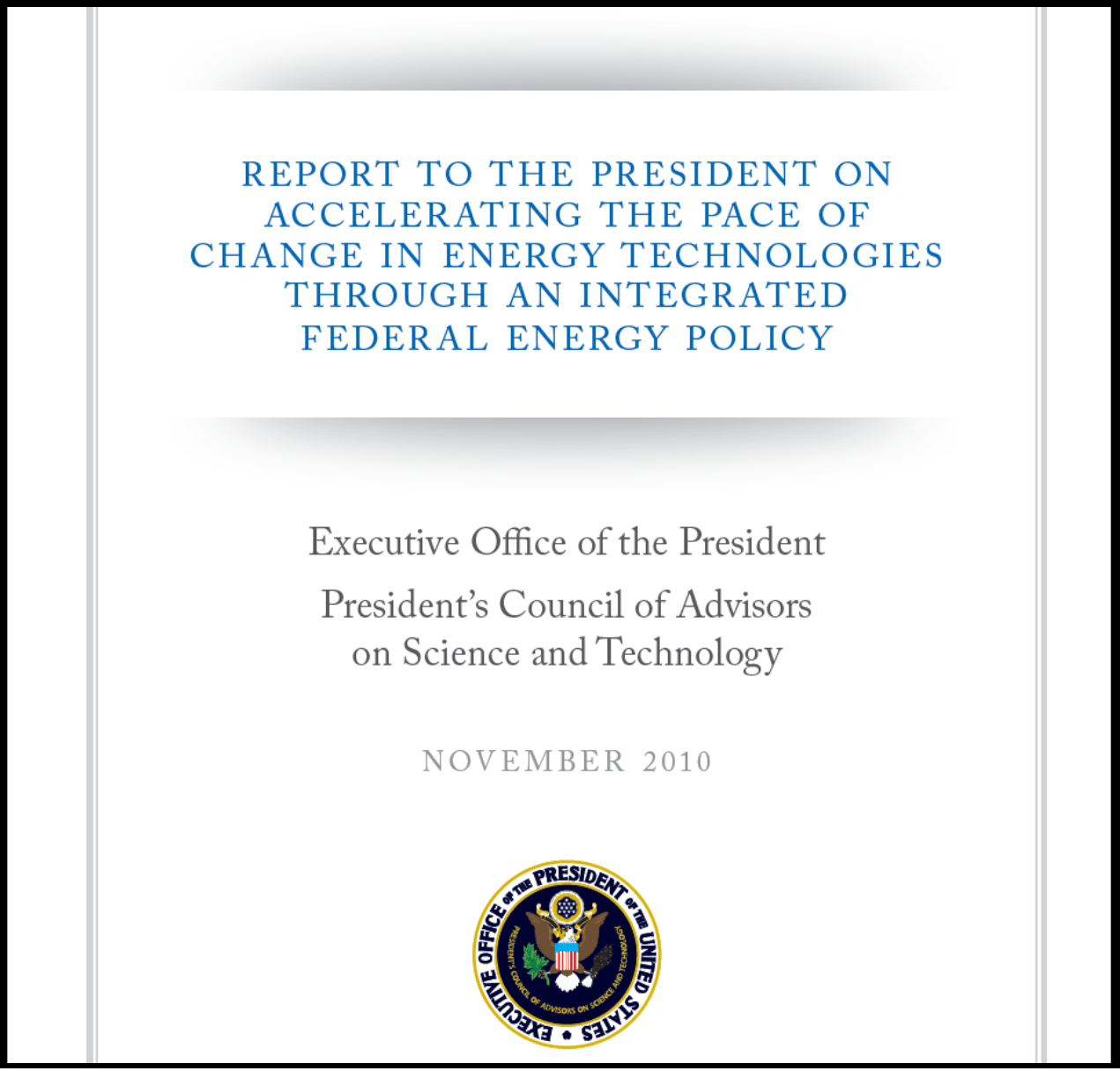
* From "A Business Plan for America's Energy Future", American Energy Innovation Council

# Excerpt from "A BUSINESS PLAN FOR AMERICA'S ENERGY FUTURE"

"One thing that is clear based upon my own career in industry and government is that when faced with major challenges of high technological content in a time of austerity, the last thing one should under-fund is R&D…to do so is the equivalent to removing an engine from an overloaded aircraft in order to reduce its weight."

Norman R. Augustine
Retired Chairman and CEO, Lockheed Martin Corp.
Former Undersecretary of the Army

Similar recommendations are in the PCAST report released today:



REPORT TO THE PRESIDENT ON ACCELERATING THE PACE OF CHANGE IN ENERGY TECHNOLOGIES THROUGH AN INTEGRATED FEDERAL ENERGY POLICY

Executive Office of the President

President's Council of Advisors on Science and Technology

NOVEMBER 2010


U.S. DEPARTMENT OF ENERGY

Energy research and development

# Advanced Research Projects Agency – Energy (ARPA-E)

(Short term, ***high risk - high reward*** research projects)

## What America's innovation could produce:

- Affordable electric vehicle batteries with 500-mile range.
- Transformative approaches to lowering the cost of bio-fuels.
- Abundant, domestic fuel produced directly from the sun.
- Solar PV energy at 1/4$^{th}$ the fully installed cost.
- Dramatically reduce carbon capture and storage (CCS) costs
- Design by computer simulation that will eliminate costly development cycles.

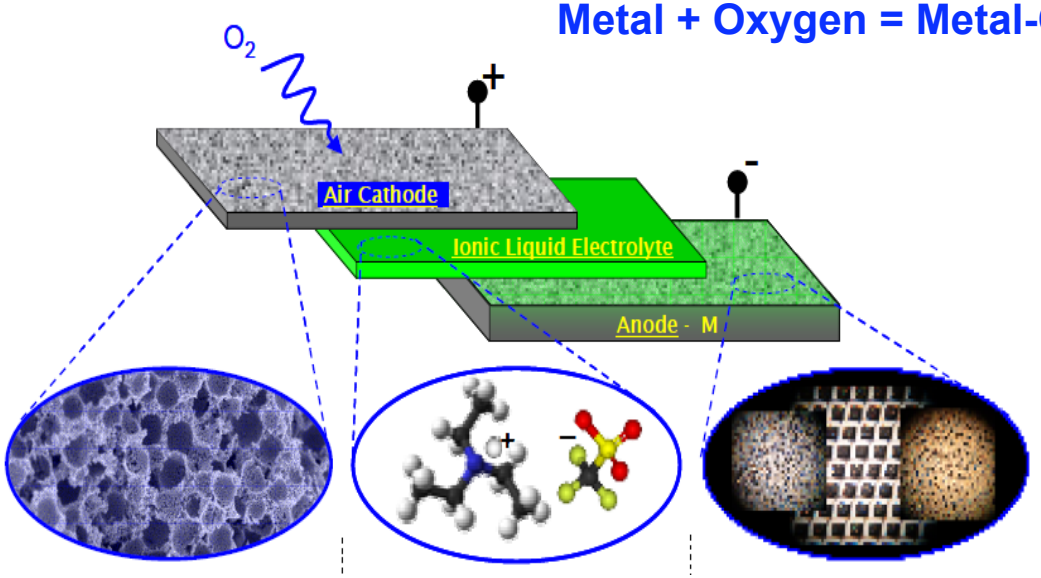
# AFFORDABLE & LONG-RANGE BATTERIES FOR CARS

ARIZONA STATE UNIVERSITY

**Electric Vehicles with a 500 mile range**
3-5X Lower Cost than Today's Lithium Ion Battery


## Metal-Air-Ionic Liquid (MAIL) Battery

**Metal + Oxygen = Metal-Oxide + Energy**




**Combines the best features of other battery technologies**

- High energy density of liquid fuel
- Long life-cycle of lithium batteries
- Low cost using abundant materials

This first-of-its-kind electric vehicle battery will be inherently safe AND financially realistic.

arpa·e

U.S. DEPARTMENT OF ENERGY

Energy research and development

## Advanced Research Projects Agency – Energy (ARPA-E)

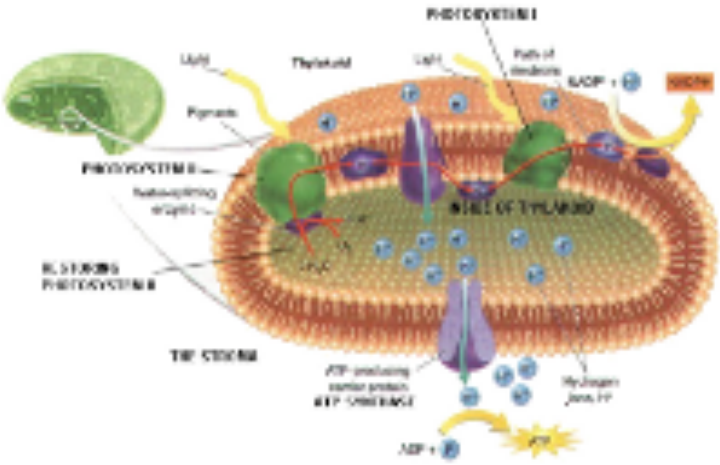
(Short term, ***high risk - high reward*** research projects)

## Energy Innovation Hubs

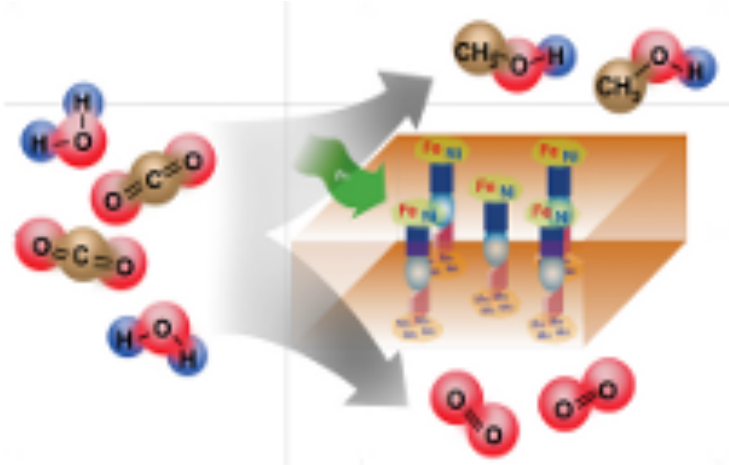
(Multi-disciplinary, highly **collaborative teams** working under one roof; “Bell Lab-lets”)

arpa·e

# Is it possible to engineer an artificial photo-synthetic system?



Photosynthesis



Artificial Photosynthesis

This would be a new way of generating energy from the sun – at least for humans. Plants do it every day.

We are essentially hoping to mimic the process of photosynthesis, using sunlight, carbon dioxide, and water to create energy.

JCAP
JOINT CENTER FOR ARTIFICIAL PHOTOSYNTHESIS

# Energy Innovation Hub:
## Fuels from Sunlight

The Fuels from Sunlight Hub aims to develop and demonstrate a manufacturable solar-fuels generator that will **produce fuel from the sun 10 times more efficiently than current crops.**

If successful, this Energy Innovation Hub would set the stage for a direct solar fuels industry.

**Producing fuels from sunlight could be a game-changer – reducing our dependence on foreign oil and enhancing energy security.**

We face a choice today: Will we maintain America's innovation leadership or will we fall behind?

We must seize the innovation opportunity.

We can't afford not to.

# There are difference between the Sputnik event of 1957 and today's "Sputnik Challenge":

1. While we are competing for leadership in energy innovation, we have much to gain by cooperating with China, India and other countries.

2. In the next two decades, China will build new infrastructure equivalent to the entire U.S.
80% of India's infrastructure in 2030 does not exist today.

3. These countries present us with new markets, a laboratory for innovation.

## In this Sputnik moment, we should:

1) Formulate sensible, *long range* energy policies that have bipartisan support to guide the private sector of U.S.

2) Increase support of energy R&D, especially where private investments don't recoup the full value of the shared social good or when a new technology would displace an embedded way of doing business.

*Wealth creation is driven by innovation.*

END