

**AVERTING THE STORM: HOW INVESTMENTS IN
SCIENCE WILL SECURE THE COMPETITIVENESS
AND ECONOMIC FUTURE OF THE U.S.**

HEARING
BEFORE THE
**COMMITTEE ON SCIENCE AND
TECHNOLOGY**
HOUSE OF REPRESENTATIVES
ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

SEPTEMBER 29, 2010

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**AVERTING THE STORM: HOW INVESTMENTS
IN SCIENCE WILL SECURE THE COMPETI-
TIVENESS AND ECONOMIC FUTURE OF THE
U.S.**

WEDNESDAY, SEPTEMBER 29, 2010

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 10:18 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Bart Gordon [Chairman of the Committee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY

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Committee on Science and Technology
Hearing on

***Averting the Storm:
How Investments in Science Will Secure the Competitiveness
and Economic Future of the U.S.***

**September 29, 2010
10:15 a.m. – 12:15 p.m.
2318 Rayburn House Office Building**

Witness List

Mr. Norman R. Augustine

*Retired Chairman and CEO of the Lockheed Martin Corporation and former
Undersecretary of the Army*

Dr. Craig Barrett

Retired Chairman and CEO of Intel Corporation

Mr. Charles Holliday, Jr.

*Chairman of the Board of Bank of America and retired Chairman of the Board and CEO
of DuPont*

Dr. C.D. (Dan) Mote, Jr.

*President Emeritus of the University of Maryland and Glenn L. Martin Institute
Professor of Engineering*

**COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

**Averting the Storm: How Investments
in Science Will Secure the Competitiveness
and Economic Future of the U.S.**

WEDNESDAY, SEPTEMBER 29, 2010
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Wednesday, September 29, 2010, the Committee on Science and Technology will hold a hearing to receive testimony from distinguished members of the 2005 “Rising Above the Gathering Storm” Committee who participated in a recent review of the 2005 report and produced an updated report entitled, *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*. Witnesses will comment on the findings included in the new report, and offer recommendations to the Committee and to Congress on how to maintain U.S. competitiveness and economic security for the long-term.

2. Witnesses

- **Mr. Norman R. Augustine**, retired Chairman and CEO of the Lockheed Martin Corporation and former Undersecretary of the Army
- **Dr. Craig Barrett**, retired Chairman and CEO of Intel Corporation
- **Mr. Charles Holliday, Jr.**, Chairman of the Board of Bank of America and retired Chairman of the Board and CEO of DuPont
- **Dr. C.D. (Dan) Mote, Jr.**, President Emeritus of the University of Maryland and Glenn L. Martin Institute Professor of Engineering

3. Overarching Questions

- Why is the promotion of science, technology and STEM education so critical to America’s prosperity? What are the principal challenges the United States faces in these areas as it competes in the global economy?
- What specific steps should the federal government take to ensure that the United States remains the world leader in innovation and job creation? What role can reauthorization of the *America COMPETES Act* play in securing U.S. competitiveness and economic security?

4. Brief Overview

- In May 2005, at the request of Congress, the National Academy of Sciences (NAS) began a study of “the most urgent challenges the United States faces in maintaining leadership in key areas of science and technology.” NAS assembled a high-level panel of senior scientists and business and university leaders and produced a report entitled, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*.
- The NAS report offered four broad recommendations: (A) increase America’s talent pool by vastly improving K–12 science and mathematics education; (B) sustain and strengthen the nation’s traditional commitment to long-term basic research; (C) make the United States the most attractive setting in which to study and perform research; and (D) ensure that the United States is the premier place in the world to innovate. The NAS report also described 20 explicit steps that the federal government could take to implement its recommendations.
- In August 2007, in response to the recommendations in the *Gathering Storm* report, Congress enacted and the President signed the *America COMPETES Act*, an Act to invest in innovation through research and development, and

to improve the competitiveness of the United States. The COMPETES conference report received overwhelming bipartisan support in both chambers of Congress, with a vote of 367 to 57 in the House, and by unanimous consent in the Senate.

- The 2007 COMPETES Act implemented the majority of the *Gathering Storm* recommendations that fell within the jurisdiction of the Science and Technology Committee and the Education and Labor Committee, and their respective counterparts in the Senate. Specifically, COMPETES placed the National Science Foundation (NSF), the National Institute of Standards and Technology's (NIST) research labs, and the Department of Energy's (DOE) Office of Science on a 7-year doubling path. In addition, the Act created ARPA-E at DOE, and addressed many specific policies to strengthen the research programs across all three of the agencies. Finally, the Act authorized a number of programs to strengthen K–12 STEM education, in particular by ensuring that current and future teachers are well prepared to teach STEM subjects. The COMPETES Act expires at the end of this month.
- It took two years to realize appropriations for the COMPETES Act. Most of this funding was provided through the American Recovery and Reinvestment Act (ARRA), a one-time, two-year infusion of funding into science and technology that helped research agencies provide support for a long backlog of world class R&D facilities and top-rated research proposals. The current budget and economic environment has challenged Administration, Congressional and stakeholder efforts to ensure sustainable increases in funding for agencies and programs authorized in COMPETES.
- In May 2010, the House passed a 5-year reauthorization of the *America COMPETES Act*, by a bipartisan vote of 262–150. The House bill reauthorized all of the programs in the 2007 Act that had been funded, repealed most programs that had never been funded, and in response to various reports since *Gathering Storm*, created a few new programs focused primarily on innovation. The Senate Committee on Commerce, Science and Transportation reported out its own reauthorization bill in July. The Senate Energy and Natural Resources released a draft of its piece of the reauthorization last week. To date, the Senate has not taken any further action on COMPETES reauthorization.
- *The Rising Above the Gathering Storm, Revisited* report¹ opens as follows: “In the five years that have passed since *Rising Above the Gathering Storm* was issued, much has changed in our nation and world. Despite the many positive responses to the initial report, including congressional hearings and legislative proposals, America’s competitive position in the world now faces even greater challenges, exacerbated by the economic turmoil of the last few years and by the rapid and persistent worldwide advance of education, knowledge, innovation, investment, and industrial infrastructure. Indeed the governments of many other countries in Europe and Asia have themselves acknowledged and aggressively pursued many of the key recommendations of *Rising Above the Gathering Storm*, often more vigorously than has the U.S. We also sense that in the face of so many other daunting near-term challenges, U.S. government and industry are letting the crucial strategic issues of U.S. competitiveness slip below the surface.”
- The report goes further to state, “Although significant progress has been made as a result of the above legislation², the Gathering Storm effort once again finds itself at a tipping point. It is widely agreed that addressing America’s competitiveness challenge is an undertaking that will require many years if not decades; however, the requisite federal funding of much of that effort is about to terminate. In order to sustain the progress that has begun it will be necessary to (1) reauthorize the *America COMPETES Act*, and (2) “institutionalize” funding and oversight of the Gathering Storm recommendations—or others that accomplish the same purpose—such that funding and policy changes will routinely be considered in future years’ legislative processes.

5. Indicators of U.S. Competitiveness

The 2010 “Gathering Storm” Committee assembled 64 factoids in support of their finding that the “nation’s outlook has worsened” since 2005. A few of them are listed

¹ http://www.nap.edu/catalog.php?record_id=12999

² America COMPETES Act and the American Recovery and Reinvestment Act

here. Citations for these data, in addition to a fuller analysis of the current state of U.S. competitiveness, can be found in the *Gathering Storm, Revisited* report.

- In 2009, 51 percent of United States patents were awarded to non-United States companies.
- In less than 15 years, China has moved from 14th place to second place in published research articles (behind the United States).
- GE has now located the majority of its R&D personnel outside the United States.
- In the 2009 rankings of the Information Technology and Innovation Foundation the U.S. was in sixth place in global innovation-based competitiveness, but ranked 40th in the rate of change over the past decade.
- The World Economic Forum ranks the United States 48th in quality of mathematics and science education.
- Ninety-three percent of United States public school students in fifth through eighth grade are taught the physical sciences by a teacher without a degree or certificate in the physical sciences.
- According to the 2008 ACT College Readiness report, 78 percent of high school graduates did not meet the readiness benchmark levels for one or more entry-level college courses in mathematics, science, reading and English.
- The United States graduates more visual arts and performing arts majors than engineers.
- Almost one-third of U.S. manufacturing companies responding to a recent survey say they are suffering from some level of skills shortages.

6. Summary of 2005 *Gathering Storm* report recommendations

The 2005 NAS report made four recommendations, each of which was supported by explicit steps that the federal government could take to implement the recommendations. These recommendations and steps are provided verbatim below.

10,000 Teachers, 10 Million Minds and K-12 Science and Mathematics Education

Recommendation A: Increase America's talent pool by vastly improving K-12 science and mathematics education.

Implementation Steps:

- A-1: Annually recruit 10,000 science and mathematics teachers by awarding four-year scholarships and thereby educating 10 million minds.
- A-2: Strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in master's programs, and Advanced Placement and International Baccalaureate (AP and IB) training programs and thus inspire students every day.
- A-3: Enlarge the pipeline by increasing the number of students who take AP and IB science and mathematics courses.

Sowing the Seeds through Science and Engineering Research

Recommendation B: Sustain and strengthen the nation's traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life.

Implementation Steps:

- B-1: Increase the federal investment in long-term basic research by 10 percent a year over the next seven years.
- B-2: Provide new research grants of \$500,000 each annually, payable over five years, to 200 of our most outstanding early-career researchers.
- B-3: Institute a National Coordination Office for Research Infrastructure to manage a centralized research infrastructure fund of \$500 million per year over the next five years.
- B-4: Allocate at least eight percent of the budgets of federal research agencies to discretionary funding.
- B-5: Create in the Department of Energy an organization like the Defense Advanced Research Projects Agency called the Advanced Research Projects Agency-Energy (ARPA-E).
- B-6: Institute a Presidential Innovation Award to stimulate scientific and engineering advances in the national interest.

Best and Brightest in Science and Engineering Higher Education

Recommendation C: Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world.

Implementation Steps:

- C-1: Increase the number and proportion of U.S. citizens who earn physical-sciences, life-sciences, engineering, and mathematics bachelor's degrees by providing 25,000 new four-year competitive undergraduate scholarships each year to U.S. citizens attending U.S. institutions.
- C-2: Increase the number of U.S. citizens pursuing graduate study in "areas of national need" by funding 5,000 new graduate fellowships each year.
- C-3: Provide a federal tax credit to encourage employers to make continuing education available (either internally or through colleges and universities) to practicing scientists and engineers.
- C-4: Continue to improve visa processing for international students and scholars.
- C-5: Provide a one-year automatic visa extension to international students who receive doctorates or the equivalent in science, technology, engineering, mathematics, or other fields of national need at qualified U.S. institutions to remain in the United States to seek employment. If these students are offered jobs by U.S.-based employers and pass a security screening test, they should be provided automatic work permits and expedited residence status.
- C-6: Institute a new skills-based, preferential immigration option.
- C-7: Reform the current system of "deemed exports."

Incentives for Innovation and the Investment Environment

Recommendation D: Ensure that the United States is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs that are based on innovation by modernizing the patent system, realigning tax policies to encourage innovation, and ensuring affordable broadband access.

Implementation Steps:

- D-1: Enhance intellectual property protection for the 21st century global economy.
- D-2: Enact a stronger research and development tax credit to encourage private investment in innovation.
- D-3: Provide tax incentives for U.S.-based innovation.
- D-4: Ensure ubiquitous broadband Internet access.

Chairman GORDON. This hearing will come to order. Good morning. I want to thank our witnesses for being here on this very busy morning. Ralph Hall looked over at me, when he looked at you, and said, we got a good group of folks here today, and I agree with him.

This is a very important hearing on securing the competitiveness of our economic future here in the United States. Just to remind everyone, in 2005, I joined then-Chairman Sherry Boehlert and Senators Lamar Alexander and Jeff Bingaman in requesting the National Academies to conduct a study assessing the state of our Nation's competitiveness. The resulting report was entitled "*Rising Above the Gathering Storm*" and foreshadowed a troubling future for our Nation—one in which our scientific leadership, technological edge, and ability to compete effectively in the global economy is uncertain.

The report maintained that, without decisive action, our children and grandchildren may very well be the first generation of Americans to inherit a standard of living lower than their parents. The report outlined specific actions to be taken to ensure the future competitiveness and prosperity of the U.S., including increasing the federal investment in long-term basic research and improving K-12 science and mathematics education.

Congress responded. In 2007, this committee took the lead in drafting legislation to implement the recommendations included in the "*Rising Above the Gathering Storm*" report. This landmark legislation, which became known as the *America COMPETES Act*, received overwhelming bipartisan support in both chambers of Congress, passed by a vote of 367 to 57 in the House, and it passed by unanimous consent in the Senate. Norm was at an event the other day where I told Senator Alexander and Senator Bingaman if they can get unanimous consent in the Senate again, then we are going to recommend them to be special envoys in the Middle East. That should be a piece of cake after working with the Senate.

Unfortunately, despite our best-laid plans, the *America COMPETES Act* is set to expire tomorrow. A little more than nine months ago, in this very room, we held a hearing with the U.S. Chamber of Commerce, the National Association of Manufacturers, the Business Roundtable, and the Council of Competitiveness on the reauthorization of the *America COMPETES Act*. That hearing was one of more than 30 hearings that we have held to inform our reauthorization process, all of which have been very supportive of reauthorization.

The Committee reported out the *America COMPETES Reauthorization Act of 2010* in April. The bill, which continued critical investments in our science and technology and renewed our commitment to future competitiveness and economic security of the United States, passed the House on a bipartisan basis at the end of May. The Senate version of the bill was reported out of the Senate Commerce Committee in July and is currently awaiting floor action.

Last week, we received a stark reminder about why the reauthorization and full funding of *America COMPETES* is so critical. The original "*Rising Above the Gathering Storm*" report Committee released an update of its 2005 report entitled "*Rising Above the Gathering Storm, Revisited, Rapidly Approaching Category Five.*" According to the update, the Nation's outlook has worsened sub-

stantially over the last five years. We now face even greater challenges in sustaining our competitive position in the world.

Our marching orders are clear. We must continue what we started and recommit ourselves to the ideas we laid out in the original COMPETES Act. If this report tells us nothing else, it tells us that the worst thing we can do is to let our efforts of reauthorization languish.

So with that I recognize the distinguished Chairman or Ranking Member from Texas, Mr. Hall.

[The prepared statement of Chairman Gordon follows:]

PREPARED STATEMENT OF CHAIRMAN BART GORDON

Good Morning. I want to thank you for being here for this important hearing on securing the competitiveness and economic future of the U.S.

In 2005, I joined then-Chairman Sherry Boehlert and Senators Lamar Alexander and Jeff Bingaman in requesting the National Academies to conduct a study assessing the state of our nation's competitiveness. The resulting report was entitled *Rising Above the Gathering Storm* and foreshadowed a troubling future for this nation—one in which our scientific leadership, technological edge, and ability to compete effectively in the global economy is uncertain. The report maintained that—without decisive action—our children and grandchildren may very well be the first generation of Americans to inherit a standard of living lower than their parents. The report outlined specific actions to be taken to ensure the future competitiveness and prosperity of the U.S., including increasing the federal investment in long-term basic research and improving K–12 science and mathematics education.

Congress responded. In 2007, this Committee took the lead in drafting legislation to implement the recommendations included in the *Rising Above the Gathering Storm* report. This landmark legislation, which became known as the America COMPETES Act, received overwhelming bipartisan support in both chambers of Congress. It passed by a vote of 367–57 in the House and by unanimous consent in the Senate.

The America COMPETES Act was more than just a rallying cry for U.S. scientific and technological leadership and competitiveness. It authorized a doubling of basic research budgets at the National Science Foundation, the National Institute of Standards and Technology, and the Department of Energy's Office of Science. It also established inventive programs to train the next generation of math and science teachers and to fund the transformational research that will lead to new industries, new businesses, and new jobs. These programs are now up and running, laying the foundation for sustained U.S. leadership in science, technology and innovation and reversing the trend we were warned about in *Rising Above the Gathering Storm*.

Unfortunately, despite our best laid plans, the America COMPETES Act is set to expire tomorrow.

A little more than 9 months ago, in this very room, we held a hearing with the U.S. Chamber of Commerce, the National Association of Manufacturers, the Business Roundtable, and the Council on Competitiveness on the reauthorization of the America COMPETES Act. That hearing was just one of more than 30 hearings we held to inform our reauthorization efforts.

This Committee reported out the America COMPETES Reauthorization Act of 2010 in April. The bill, which continued critical investments in science and technology, and renewed our commitment to the future competitiveness and economic security of the U.S., passed the House on a bipartisan basis at the end of May. The Senate version of the bill was reported out of the Senate Commerce Committee in July and is currently awaiting floor action.

Late last week, we received a stark reminder about why a reauthorization of the America COMPETES Act is so critical. The original *Rising Above the Gathering Storm* Committee released an update to its 2005 report entitled *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*. According to the update, the nation's outlook has worsened substantially over the last 5 years and we now face even greater challenges in sustaining our competitive position in the world.

Our marching orders are clear. We must continue what we started and recommit ourselves to the ideals we laid out in the original COMPETES Act. If this report tells us anything, it tells us that the worst thing we can do is let our efforts at reauthorization languish.

Today's hearing may very well be the last hearing I chair in Congress. While I am honored to have such a distinguished group of witnesses with us today to mark

this occasion, I wish we were here to discuss a less sobering topic. At the same time, I am confident that, in the America COMPETES Act and the pending reauthorization bill, we have laid the groundwork to reverse the troubling trajectory laid out in this latest report and to ensure our competitiveness and long-term prosperity. I fully expect that the COMPETES reauthorization bill will be enacted by the end of the year, and that Congress will have once again answered this call to action.

Mr. HALL. Thank you, Mr. Chairman, and I do, I really do thank you, and I am beginning to feel like these hearings with you and my friends and all of our friends, Mr. Augustine, are just episodes of *déjà vu*. We all agree that a strong, skilled, and STEM-educated workforce is critical to our Nation's ability to compete and our ability to remain the leader in innovation, and is our key to economic success.

And you almost described the Senate properly, but my predecessor, Mr. Rayburn, had a new, young Democrat come in and went to see the Speaker. He said, show me which Republican you want me to take care of, and I will just leave the chimney burning. He said, no, no, son. The Republican in the House is not the enemy of the Democrat. The Democrat in the House is not the enemy to the Republican. The enemy is the Senate. I think you had it figured out.

Almost four years ago we sat in this room with almost the same panel and officially kicked off what was to become the *America COMPETES Act* as the Chairman has set out. As everyone here is aware, *America COMPETES* was a culmination of recommendations from the often-quoted "*Rising Above the Gathering Storm*" report, former President Bush's American Competitiveness Initiative, and efforts begun by this committee under Republican leadership and continued by you, Mr. Chairman. We all worked in a bipartisan fashion on this endeavor, and I am proud of our accomplishments.

My message is exactly the same today as it was then and has been throughout our current reauthorization of COMPETES. If America is going to remain on top in the evolving world economy, we must be dedicated to encouraging innovation and entrepreneurship while simultaneously cultivating a scientifically and technologically-astute future workforce.

And I need to get a speech that doesn't have so many big words in it.

While my message hasn't changed, and seemingly neither has the message of *Gathering Storm* Committee members before today, unfortunately, our economy has changed, and I am pleased to see that the *Gathering Storm* revisited report acknowledges "the great difficulty of carrying out the *Gathering Storm* recommendations such as doubling the research budget in today's fiscal environment . . . with worthy demand after worthy demand confronting budgetary realities."

However, I take some issue with not doubling the budget then and now just making an overweight aircraft flight worthy by removing an engine. That is a pretty good line. That is Norm. Rather, I would suggest that the prudent approach would be to ensure that our current investments are creating a successful return on investment and are being more efficiently utilized.

Perhaps a better analogy would be that in order to make an overweight aircraft flight worthy, one needs to offload excess baggage,

particularly in today's economic uncertainties. We need to make sure that we are reaping the benefits of the numerous initiatives called for in the initial *Gathering Storm* report and set forth in *America COMPETES* before creating others.

I am sure it troubles all of us on this committee to hear that we continue to be on a decline in a variety of science and technology areas, particularly when we have already legislated numerous recommendations, set forth in the 2005 report. This reinforces my belief, however, that other issues beyond funding levels are holding us back. I believe much more needs to be done to all of us, not just the Federal Government, to keep and in some cases restore the United States to science and technology innovation prominence across the board. Everyone has a role. The private sector needs to step up, our schools and teachers need to step up, parents need to step up, and our children need to step up.

I look forward to the testimony of our distinguished panel today because there is no doubt that we still have much to accomplish. Everyone here knows of my deep admiration and respect for Mr. Augustine and the other four here. Some six years ago I suggested that he might make a good candidate for President, and he hasn't spoken to me since, but I am serious about that, and I see four there that would make good candidates.

I sincerely expect we will hear that it takes a lot more than just throwing money at R&D to help us achieve our goals, and that *America COMPETES* is just one aspect of improving American's competitiveness. I hope to hear them speak at length on the other areas raised in their revised report, a majority of which are not within this committee's jurisdiction, but are major contributing factors to our competitiveness, and encouraging private sector innovation through tax credits, a positive regulatory environment, tort reforms, protection of intellectual capital, and other such programs will catapult the American economy and make us more competitive globally and bring new products and jobs to the American people.

And, Mr. Chairman, I thank you, and I yield back my time if I have any left.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Thank you, Mr. Chairman. I'm beginning to feel like these hearings with you and my good friend, Norm Augustine, are just episodes of déjà vu. We all agree that a strong, skilled and STEM-educated workforce is critical to our Nation's ability to compete, and our ability to remain the leader in innovation our key to economic success.

Almost four years ago we sat in this room with almost this same panel and "officially" kicked off what was to become the America COMPETES Act. As everyone here is aware, America COMPETES was the culmination of recommendations from the oft-quoted *Rising Above the Gathering Storm (Gathering Storm)* Report, former President Bush's American Competitiveness Initiative, and efforts begun by this Committee under Republican leadership and continued by you, Mr. Chairman. We all worked in a bipartisan fashion on this endeavor, and I am proud of our accomplishments.

My message is the exact same today as it was then and has been throughout our current reauthorization of COMPETES: If America is going to remain on top in the evolving world economy, we must be dedicated to encouraging innovation and entrepreneurship, while simultaneously cultivating a scientifically and technologically astute future workforce.

While my message hasn't changed, and seemingly neither has the message of the *Gathering Storm* Committee members before us today, unfortunately, our economy has.

I am pleased to see that the *Gathering Storm Revisited* Report acknowledges "the great difficulty of carrying out the *Gathering Storm* recommendations, such as doubling the research budget, in today's fiscal environment . . . with worthy demand after worthy demand confronting budgetary realities." However, I take some issue with not doubling the budget being analogous to "making an over-weight aircraft flight-worthy [by removing] an engine." Rather, I would suggest that the prudent approach would be to ensure that our current investments are creating a successful return on investment and are being more efficiently utilized. Perhaps the better analogy would be that in order to make an over-weight aircraft flight-worthy, one needs to offload excess baggage. Particularly in today's economic uncertainties, we need to make sure that we are reaping the benefits of the numerous initiatives called for in the initial *Gathering Storm* report and set forth in America COMPETES before creating others.

I am sure it troubles all of us on this Committee to hear that we continue to be on a decline in a variety of science and technology areas, particularly when we have already legislated numerous recommendations set forth in the 2005 report. This reinforces my belief, however, that other issues beyond funding levels are holding us back. I believe much more needs to be done by all of us, not just the federal government, to keep, and in some cases restore, the United States to science and technology innovation prominence across the board. Everyone has a role. The private sector needs to step up, our schools and teachers need to step up, parents need to step up, and our children need to step up.

I look forward to the testimony of our distinguished panel today, because there is no doubt that we still have much to accomplish. Everyone here knows of my deep admiration and respect of Norm Augustine, and I am eager to hear what he has to say, as well the rest of our witnesses. I sincerely expect we will hear that it takes a lot more than just throwing money at R&D to help us achieve our goals and that America COMPETES is just one aspect of improving America's competitiveness. I hope to hear them speak at length on the other areas raised in their revised report, a majority of which are not within this Committee's jurisdiction, that are major contributing factors to our competitiveness. Encouraging private sector innovation through tax credits, a positive regulatory environment, tort reform, protection of intellectual capital, and other such programs will catapult the American economy, make us more competitive globally, and bring new products and jobs to the American people.

Thank you, Mr. Chairman.

Chairman GORDON. Thank you, Mr. Hall.

Ms. EDWARDS. Mr. Chairman.

Chairman GORDON. Yes. The gentlelady from Maryland is recognized.

Ms. EDWARDS. Thank you, Mr. Chairman, and I know it is not our custom, but I wanted to take this moment, and I know that the Ranking Member would do it as well, to acknowledge that this is probably your last sitting in the Chair in this committee, and I just want you to know how much I really appreciate—I know that we all do—your leadership and your guidance of our Committee. It is one of the committees in the Congress that operates in the most unified way on so many issues, this one included, and so I just want to thank you for your leadership and your guidance and your service in the United States Congress.

Chairman GORDON. Well, thank you. Let us not bury the corpse quite yet. Let us let it get cold. We have got a lame duck session, we have got more work to do, we have got to get this COMPETES passed, but thank you for your very nice words.

Mr. HALL. I thought she was talking about me there for a while.

Chairman GORDON. Well, Mr. Hall, I wish that we had an expanded jurisdiction, because if we did, we would take care of those other issues that you mentioned. It is a shame that the United

States has the second highest corporate tax rate in the world, and we certainly have to have other changes.

But y'all, what we have is what is on our plate, so we want to deal with that and deal with it well, and we—if there are Members who wish to submit additional opening statements, your statements will be added to the report at this point.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good Morning. Thank you, Mr. Chairman, for holding today's hearing to receive testimony on the report, *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*, a five-year review of the state of science education and innovation in the U.S.

In 2005, the National Academy of Sciences (NAS) released its landmark report, *Rising Above the Gathering Storm*, which recommended Congress and the administration immediately invest in science education, research, and technology to preserve the U.S. role as the world leader in innovation. In response to this report, Congress passed the America COMPETES Act with bipartisan support in 2007. However, the important programs established by this act, particularly for science, engineering, technology, and mathematics (STEM) education, were underfunded or unfunded for two years until the passage of the American Recovery and Reinvestment Act in 2009. Without sufficient funding, COMPETES did not have the impact Congress intended.

Gathering Storm, Revisited makes clear these efforts unless the government makes innovation a priority and provides adequate funding, the U.S. remains at risk of falling behind in developing and patenting new technology; publishing cutting edge research; training the next generation of scientists and engineers; and maintaining the most competitive workforce in the world. As this report demonstrates, it remains imperative that U.S. students, teachers, businesses and workers are prepared to continue leading the world in innovation, research and technology.

I am interested in hearing from our witnesses what steps Congress and the administration must take to achieve the original goals of *Gathering Storm*, and what new challenges were identified in reviewing this report five years later. In particular, I would like to hear how the reauthorization of America COMPETES, which expires at the end of this month, may achieve these goals and overcome the roadblocks to innovation, especially with shrinking budgets and lower private sector investment in research and development.

Further, I share the concerns of our witnesses regarding the steady decline of STEM education in the U.S., particularly in grades K–12, particularly with the elimination of several K–12 STEM programs in the House reauthorization of COMPETES. Since coming to Congress, I have recognized investment in STEM education as key to keeping our economy strong and growing. I am interested to hear from our witnesses what steps they recommend to strengthen our support for STEM education at every grade level.

Finally, for many students, pursuing a college or advanced degree in STEM fields is not feasible, particularly in this economy. These students will enter the workforce after completing vocational education or receiving an associate degree from a community college. Providing these students a strong STEM background is no less important, however, than training engineers and researchers, particularly if they enter medical or manufacturing careers. As you demonstrate in *Gathering the Storm, Revisited*, one-third of manufacturing companies cannot find employees with the appropriate skill sets for innovative manufacturing. I am interested in how improvements to STEM programs at community colleges, such as the partnership between community colleges and Manufacturing Extension Partnerships (MEPS) included in the House COMPETES reauthorization, may address this gap.

I welcome our panel of witnesses, and I look forward to their testimony. Thank you again, Mr. Chairman.

At this time I would like to introduce our witnesses. First, Mr. Norm Augustine is the Retired Chairman and CEO of Lockheed Martin Corporation and former Undersecretary of Army. I think “retired” is an odd term to be using for him and for Dr. Craig Barrett, the also so-called retired Chairman and CEO of Intel. I think

that they probably would like to go back and get a rest running companies rather than all of the volunteer efforts they are doing, and Dr. Barrett, we know that when you leave your beloved Montana to come here, it is on a mission that you feel strongly about, and we also thank you for taking the Chairmanship of Change the Equation, rounding up 100 major CEOs that recognize the importance of our STEM education, and trying to move that ball forward.

And Mr. Charles Holliday is the Chairman of the Board of Bank of America and the retired Chairman of the Board and CEO of DuPont, and once again, we know there are other demands, but you have made really service, your patriotic service to the country important. Thank you for that. Dr. Dan Mote is the President Emeritus of the University of Maryland as well as the Glenn L. Martin Institute Professor of Engineering, and I am sure they would like to see you more at the University of Maryland, but you, too, have been giving of your time.

So, Mr. Augustine, please begin your testimony.

**STATEMENT OF NORMAN R. AUGUSTINE, RETIRED CHAIRMAN
AND CEO OF THE LOCKHEED MARTIN CORPORATION AND
FORMER UNDERSECRETARY OF THE ARMY**

Mr. AUGUSTINE. Mr. Chairman, Congressman Hall, and Members of the Committee, thank you for this opportunity to appear on behalf of my colleagues on the *Gathering Storm* Committee, including my three colleagues here at this table. I would like to submit a formal statement for the record with the Committee's permission.

Chairman GORDON. That is without objection.

Mr. AUGUSTINE. Thank you. Five years ago, as you pointed out, Mr. Chairman, this committee together with its counterpart in the Senate asked the National Academies to examine America's future competitiveness outlook. The members of the Academies Committee quickly interpreted that to mean the ability of all Americans to have the opportunity to compete for quality jobs in the new global economy.

Our conclusion, I am sorry to say, was that we were on a path at the time whereby we were likely to suffer sustained unemployment at very high levels because Americans simply won't be able to compete successfully for jobs. The only solution we could see to that was to be among the world's leaders at innovation, and to do that we pointed to 20 actions that would be required, at least as a starting point. The two highest priorities of those were to vastly improve the Nation's K-12 education system and to double the funding for basic research, primarily at our Nation's research universities.

We emphasized the importance of science and engineering because numerous studies have shown that over half the growth of the GDP for many years has been attributable directly to advancements in science and in engineering.

We have made progress, thanks to the work of this committee to a very large degree. The *America COMPETES Act* made possible a number of important actions that have taken place. The research budget, at least, has begun on the new trajectory we proposed; ARPA-E [Advanced Research Projects Agency-Energy] is, I think, successfully launched and under way; the R&D tax credit was con-

tinued; the State Department reassessed the requirements that were being imposed for visa applicants who want to be students in this country. But there is a problem, and the problem is that almost all the good things that have been done have been dependent upon funding from the stimulus package and from authorization from the *America COMPETES Act*. And as you know, both of these are due to expire momentarily. So we stand on a precipice in terms of the accomplishments that have been made.

There are a number of things that have gone against us during the past five years since the study was first done. Others are getting better quickly. They are building new universities. This year there will be 98,000 Chinese students going to school in America, and 103,000 Indian students going to school in America, many of them studying engineering and science.

Secondly, the stress on the federal budget, as the people in this room would know so well, is making it even more difficult to implement many of the things we need to do to be more competitive as a nation.

Thirdly, our universities, something that was unthought of five years ago, today are being very much stressed in the sense of reduced financial support from states, reduced endowments. And this is resulting in other countries' universities targeting and picking off some of the finest researchers and professors at our universities.

And finally, at the time we met five years ago, the biosciences had been well funded—more accurately, the health sciences—whereas since that time they, too, have suffered the impact of inflation and some reductions.

I would share just a few statistics with you. We are used to thinking of America as being number one. Today, some facts based on data from respected sources: in terms of innovation-based competitiveness, we have now been ranked number six; our fraction of the young workforce with a high school diploma, we rank 11th in the world. Our college completion rate, we are 16th; our high school completion ranked 20th. In achievement among 17 year olds in science, we rank 21st. Broadband internet access, we rank 22nd; life expectancy at birth, 24th; achievement of 17 year olds in mathematics, 25th; the fraction of college graduates who study science and engineering, 27th. In rate of improvement in competitiveness, 40th; the quality of math and science K–12 education, 48th; and the density of mobile telephone subscribers, 72nd.

Now, that is not the America that I like to think of us as being. And can you imagine if our—when our Olympic team finished fourth in basketball, you recall the impact it had and what we did about it. My hope is that we can have an even more energetic impact to these circumstances.

This isn't the America that I would want to see for my grandchildren, and I suspect many in this room will share that view for their children and grandchildren.

Thank you very much.

[The prepared statement of Mr. Augustine follows:]

PREPARED STATEMENT OF NORMAN R. AUGUSTINE

Chairman Gordon and Members of the Committee, thank you for this opportunity to discuss the results of the report prepared for the National Academies that was released this past week and is titled, "Rising Above the Gathering Storm, Revisited:

Rapidly Approaching Category 5.” I would also like to take this opportunity to thank the Committee for its key role in supporting science and engineering in America and, through those disciplines, improving the quality of life of all our nation’s citizens.

The most recent report, “Rising Above the Gathering Storm, Revisited” traces its origin to a request by this Committee and its counterpart in the Senate. That request was made on a bipartisan basis some five years ago and resulted in a National Academies study that came to be known as the “Gathering Storm study” after the first line in the title of the report that presented its findings. The request from the Congress asked that the Academies address America’s future competitiveness outlook . . . which the Academies committee quickly came to define as the ability for all Americans to compete for quality jobs in the new global marketplace. It is those jobs that will largely define the quality of life that will be enjoyed by working individuals and their families, and it is the income from those jobs that will provide the tax resources needed by our government to provide the benefits that we all have come to expect, such as homeland security, healthcare, social security and much, much more. I believe it is fair to state that the report enjoyed strong bipartisan support of the members of this body.

The original National Academies committee was composed of 20 members having rather diverse professional backgrounds, including then present and former CEO’s of large firms, presidents of major public and private universities, the head of a state public K–12 school system, and three Nobel Laureates. The principal result of their deliberations was a series of 20 specific, interdependent actions that could be taken by the federal government to enhance the ability of Americans to compete for jobs in the increasingly competitive world employment market. This prioritized list was headed by the imperative to improve the nation’s K–12 education system and was immediately followed by the need to double within seven years the nation’s real investment in basic research.

The report placed particular emphasis on science and engineering because numerous studies have indicated that at least half the growth in the nation’s GDP during the past half-century can be attributed to advancements in these fields. With the accelerating pace of science and engineering one can reasonably expect the creation of jobs in the next 50 years to exhibit an even greater dependency on developments in such disciplines. It should be noted in this regard that the Gathering Storm committee considers jobs in science and engineering to be means to an end and not an end in themselves . . . that is, only four percent of America’s workforce is employed in science and engineering—the disproportionate importance of these professions stems from the fact that they create jobs for a very large number of other citizens.

In its original report, released exactly five years ago, the Gathering Storm committee concluded that America was on a path whereby large numbers of its citizens would not be competitive for quality jobs—and that chronic built-in unemployment would be a likely consequence of structural weaknesses . . . again, most prominently, under-investment in education and under-investment in the creation of knowledge through research—the underpinnings of innovation.

A number of important initiatives were undertaken following the completion of the work of the Gathering Storm committee as well as that of numerous other groups, including the establishment of ARPA–E, increasing research funding approximately on the profile the Gathering Storm committee recommended, implementing steps to improve K–12 education, strengthening policies affecting student visa applicants and funding for research and development tax credits.

However, most of the above actions were authorized under the America Competes Act and were funded as part of the economic recovery package. As you know, the Competes Act requires reauthorization this year and the recovery package is approaching its sunset insofar as it serves as a source of funding. Thus, the efforts that are now underway find themselves on a budgetary precipice.

Underlying the Gathering Storm committee’s findings was such evidence as that cited by Frances Cairncross writing in *The Economist* who noted that “distance is dead” . . . a victim of the advent of modern aircraft and information systems. Distance no longer matters to those seeking employees for a large variety of quality jobs. In the words of Tom Friedman, in his book, *The World is Flat*, “Globalization has accidentally made Beijing, Bangalore and Bethesda next door neighbors.” This is particularly true when Americans must compete for jobs.

The report released this past week, “Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5,” was prepared at the request of the presidents of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The same Committee that prepared the original Gathering Storm study conducted the more recent examination—with the exception of three members who were unable to participate. One of these members is our much ad-

mired colleague and Nobel Laureate, Josh Lederberg, who passed away. The other two are currently serving in key roles in the federal government. The findings of the remaining 17 Committee members were unanimous.

The Committee focused on events occurring during the past five years that have impacted the initial conclusions and recommendations and their continued appropriateness. The members found the need to continue to support the original proposed actions even more compelling and urgent today than at the time they were initially proposed. Both specific events as well as overarching matters that occurred during the five years since the initial report was prepared led to this conclusion. Examples of the former include:

- Six million more American youth have dropped out of high school since the original Gathering Storm report was produced and each of these individuals now faces an extraordinarily high prospect of prolonged unemployment.
- The World Economic Forum has ranked the U.S. 48th in quality of mathematics and science education.
- In 2009, 51 percent of U.S. patents were awarded to non-U.S. companies.
- Federal funding of research in the physical sciences as a fraction of GDP fell by 54 percent in the 25 years after 1970. The corresponding decline in engineering funding was 51 percent.
- The Information Technology and Innovation Foundation ranked the U.S. in sixth place in global innovation based competitiveness and ranked the U.S. 40th in the rate of improvement over the past decade.
- China has now replaced the United States as the world's number one technology exporter.
- Eight of the 10 global companies with the largest R&D budgets have established R&D facilities in China, India, or both.
- General Electric, like a growing number of other firms, has relocated the majority of its R&D personnel outside the United States.
- Ninety-three percent of U.S. public schools in fifth through eighth grade are taught the physical sciences by a teacher without a degree or certificate in the physical sciences.
- The United States ranks 27th among developed nations in the proportion of college students receiving undergraduate degrees in science or engineering.
- The United States ranks 20th in high school completion rate among industrialized nations and 16th in college completion rate.
- An American company recently opened the world's largest private solar R&D facility . . . in Xian, China.
- Between 1996 and 1999, 157 new drug formulations were approved by the United States. In a corresponding period 10 years later, the number dropped to 74.
- Two-thirds of those receiving PhD's in engineering from U.S. universities are foreign-born. These individuals increasingly indicate their intention eventually to return to their home countries.
- All of the National Academies "Gathering Storm" Committee's recommendations could have been fully implemented with the sum Americans spent on cigarettes—with \$60B a year left over.

Turning to macroscopic developments, four circumstances warrant particular mention. The first of these is that other nations are rapidly improving their competitive ability due to a major emphasis on education, including the creation of new science- and engineering-focused universities and very progressive tax policies that favor innovation-driven firms.

Second, the ability of the U.S. to respond to the competitiveness challenges it faces has been increasingly hindered by the extraordinary budget pressures faced by the federal government as well as state and local governments.

Third, altogether unforeseen at the time of the Gathering Storm study five years ago, America's higher education system, long the gold standard of the world, is now being severely threatened. The source of this challenge is the serious financial condition of many states plus the loss of endowments suffered during the recent financial downturn. As a result, universities are taking heretofore largely unprecedented actions, including mandatory furloughs for faculty, faculty layoffs and large increases in tuition. Concurrently, universities in other nations are seeing this as an opportunity to attract many of the finest researchers and educators from America's educational institutions, particularly its research universities.

Fourth, at the time the original Gathering Storm study was conducted, the biosciences, or more precisely the health sciences, had just benefitted from a doubling of federal research funding and therefore were not given primary consideration in the Academies' work. Since that time, however, this upward trend has been reversed and the effects of inflation have further taken their toll.

The underlying dilemma faced by a firm seeking to determine where to build a new R&D facility or factory is illustrated by the following set of choices comparing two nations from a competitiveness standpoint:

In Country A, the average non-professional worker ranks in the lower quartile of the global high school class and expects to be paid a wage of \$17 per hour plus an additional third of that amount in benefits; the nation's economy is mature in terms of growth potential; it has the second highest corporate tax rate in the world; and the average firm spends almost three times as much on litigation as on research. In Country B, the average non-professional worker ranks in the top 10 percent of the global high school class and is eager to work for \$1.50 per hour with no additional benefits; five-year tax holidays are commonly granted to startup high tech firms; five to eight professional employees can be hired for the cost of one in Country A; and the domestic market for products is growing exponentially.

Country A is, of course, the United States, and even the most loyal CEO's and boards of directors of American firms will, given their fiduciary responsibilities, generally elect to move to Country B.

In summary, the Gathering Storm committee unanimously concluded that America's competitive situation is even more perilous today than it found it to be five years ago. The recommendations in the initial report are deemed still to be entirely appropriate—the task being to implement those recommendations on a continuing basis. Doing so will require reauthorizing the America Competes Act and providing the funding needed to carry out the above-mentioned recommendations.

It is noted that meeting the competitiveness challenge is a marathon, not a sprint, and will thus require our enduring efforts. It is the Gathering Storm committee's conviction that this is an endeavor in which all Americans can unite since the fundamental issue is the quality of life we will leave to our children and our grandchildren.

Thank you for affording me this opportunity to share with you the findings of my colleagues on the Gathering Storm committee. I would be pleased to address any questions you might wish to raise.

BIOGRAPHY FOR NORMAN R. AUGUSTINE

NORMAN R. AUGUSTINE was raised in Colorado and attended Princeton University where he graduated with a BSE in Aeronautical Engineering, magna cum laude, and an MSE. He was elected to Phi Beta Kappa, Tau Beta Pi and Sigma Xi.

In 1958 he joined the Douglas Aircraft Company in California where he worked as a Research Engineer, Program Manager and Chief Engineer. Beginning in 1965, he served in the Office of the Secretary of Defense as Assistant Director of Defense Research and Engineering. He joined LTV Missiles and Space Company in 1970, serving as Vice President, Advanced Programs and Marketing. In 1973 he returned to the government as Assistant Secretary of the Army and in 1975 became Under Secretary of the Army, and later Acting Secretary of the Army. Joining Martin Marietta Corporation in 1977 as Vice President of Technical Operations, he was elected as CEO in 1987 and chairman in 1988, having previously been President and COO. He served as president of Lockheed Martin Corporation upon the formation of that company in 1995, and became CEO later that year. He retired as chairman and CEO of Lockheed Martin in August 1997, at which time he became a Lecturer with the Rank of Professor on the faculty of Princeton University where he served until July 1999.

Mr. Augustine was Chairman and Principal Officer of the American Red Cross for nine years, Chairman of the Council of the National Academy of Engineering, President and Chairman of the Association of the United States Army, Chairman of the Aerospace Industries Association, and Chairman of the Defense Science Board. He is a former President of the American Institute of Aeronautics and Astronautics and the Boy Scouts of America. He is a current or former member of the Board of Directors of ConocoPhillips, Black & Decker, Proctor & Gamble and Lockheed Martin, and was a member of the Board of Trustees of Colonial Williamsburg. He is a Regent of the University System of Maryland, Trustee Emeritus of Johns Hopkins and a former member of the Board of Trustees of Princeton and MIT. He is a member of the Advisory Board to the Department of Homeland Security, was a member of the Hart/Rudman Commission on National Security, and served for 16 years on the President's Council of Advisors on Science and Technology. He is a member of the

American Philosophical Society, the National Academy of Sciences and the Council on Foreign Affairs, and is a Fellow of the National Academy of Arts and Sciences and the Explorers Club.

Mr. Augustine has been presented the National Medal of Technology by the President of the United States and received the Joint Chiefs of Staff Distinguished Public Service Award. He has five times received the Department of Defense's highest civilian decoration, the Distinguished Service Medal. He is co-author of *The Defense Revolution* and *Shakespeare in Charge* and author of *Augustine's Laws* and *Augustine's Travels*. He holds 24 honorary degrees and was selected by Who's Who in America and the Library of Congress as one of "Fifty Great Americans" on the occasion of Who's Who's fiftieth anniversary. He has traveled in over 100 countries and stood on both the North and South Poles of the earth.

Chairman GORDON. Thank you, Mr. Augustine.
Dr. Barrett is recognized.

**STATEMENT OF CRAIG BARRETT, RETIRED CHAIRMAN AND
CEO OF INTEL CORPORATION**

Dr. BARRETT. Thank you, Mr. Chairman. It is a pleasure to be invited here to testify today. I have also submitted a written testimony. I would like to supplement that kind of 'freelance,' if you will.

I do not represent Intel, although I worked there for 35 years, and I am still very proud of that company. It employs nearly 50,000 U.S. citizens, does 75 percent of its manufacturing still here in the United States, and 85 to 90 percent of its R&D budget is spent here in the United States, and the R&D budget is substantially greater than that of the National Science Foundation. So it is an appreciable investor in R&D here in the U.S.

While CEO and then Chairman of Intel, I had the privilege to travel quite a bit. I probably visited over 100 countries for Intel, had the opportunity to speak to business leaders, academic leaders in those countries, and government leaders. And during those conversations I always heard exactly the same thing, and I think it is very true here in the United States: every one of those countries was interested in increasing its competitiveness.

The 'competitiveness quotient,' so to speak, was derived by three factors. One was the education level of the workforce. You can't be number one unless you have the number one education system. The investment in new ideas, the investment in R&D. It is new ideas that create the next generation of products, services, and create wealth. And the third feature they were interested in was the environment, the environment simply to let smart people get together with smart ideas, and do something wonderful. And the environment is partially set by society, partially set by government rules and regulations, tax rates, intellectual property protection, ability to start a company, bankruptcy laws, a whole series of issues.

"*Rising Above the Gathering Storm*" and the *America COMPETES Act* focus on those three issues; smart people, smart ideas, and the right environment, and five years after the fact—that the initial report was introduced—the follow-up report that Norm Augustine mentioned. I think we are not battling particularly well on either of those or any of those three topics.

I would fully support the reauthorization of the *America COMPETES Act*. I do not think it is solely an issue of government, though, as the Chairman mentioned. It is an issue for society and

private sector to become involved, and you mentioned the private sector in the Change the Equation group, which was just announced a week or so ago here in Washington, DC. About 110 CEOs of major U.S. corporations involved in science and technology, but also involved in consumer goods and many other industries, have banded together to do their part to promote science, technology, engineering, and mathematics education and interest in the youth of America. I think one of our biggest challenges is getting the younger generation interested in what is going forward.

The Change the Equation group is committed to really three major efforts. One is improve the teaching of science and math in K-12, better science and math teachers. Secondly, it is involved in getting kids interested in science and math out of school. That is such things as robotics competitions, science fairs, a number of activities that the private sector is already involved with. We want to amplify those and spread them geographically across the United States. In fact, the first-year goal is to have programs of that type in 100 new geographic areas where the programs do not exist today over the next year.

The third thing we are interested in doing is, in fact, using the CEOs in the private sector as the voice of advocacy for the basic tenets of the *America COMPETES Act* and the “*Rising Above the Gathering Storm*” recommendations—dealing with state, local legislators to, in fact, mobilize them to focus on STEM issues, on K-12 issues, on research, university issues, and job creation in their local areas.

I think we are off to a good start in that respect. By golly, if I look at what is going on around the world, we have a heck of a lot of work in front of us, and unless the *America COMPETES Act* is reauthorized going forward, and coupling that public sector set of programs with the private sector, I think we are going to continue to struggle.

Thank you.

[The prepared statement of Dr. Barrett follows:]

PREPARED STATEMENT OF CRAIG BARRETT

Thank you, Mr. Chairman, for the opportunity to testify before you today. I also want to thank Ranking Member Hall and all the members of the Committee on Science and Technology for your support for basic research and development and your commitment to improving education standards for our children.

My name is Craig Barrett and I am the former Chairman and CEO of Intel Corporation. Intel is the world’s largest manufacturer of semiconductors, three-quarters of which are manufactured here in the United States. Intel employs more than 40,000 people in the United States and spends billions of dollars each year on research and development, most of which is done in the U.S.

As a leading information technology company, Intel is dependent on highly-skilled engineers, mathematicians and scientists to maintain its competitive position in the marketplace. Increasingly, however, it is difficult for companies like Intel to find the qualified American workers they need to develop new and innovative products. Our competitors around the world are investing more in their education systems and producing workers who are better prepared for the high-skilled jobs of the future.

As a country, we need to re-double our commitment to educating our children and investing in basic research that will lead to breakthrough technological developments. That is why I support and encourage your efforts to reauthorize the America Competes Act.

I am pleased to be here with you today to examine where we stand on the challenge of U.S. Competitiveness five years after the National Academy of Engineering issued its *Gathering Storm* report, which I had the honor to contribute to under the direction of our chair Norm Augustine.

As you know, the Gathering Storm report found that as a country we need to create high-quality jobs for Americans and develop clean, affordable and reliable energy. We made four recommendations designed to help us achieve those goals:

1. Increase America's talent pool by vastly improving K–12 science and mathematics education.
2. Sustain and strengthen the nation's traditional commitment to long-term basic research that has the potential to be transformational and to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life.
3. Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit and retain the best and brightest students, scientists and engineers from within the United States and throughout the world.
4. Ensure that the United States is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs based on innovation by such actions as modernizing the patent system, realigning tax policies to encourage innovation and ensuring affordable broadband access.

Following the issuance of this report, Congress took steps to address many of these recommendations by adopting the America Competes Act of 2007. That legislation called for a doubling of the research budgets for key agencies like the National Aeronautics and Space Administration (NASA), the National Institute of Standards and Technology (NIST), the National Oceanic and Atmospheric Administration (NOAA), The National Science Foundation (NSF) and the Department of Energy (DOE). The Act also directed significant resources to educating students in the key areas of science, technology, education and mathematics.

But despite the important first steps taken in 2007, the job is not finished. That is why I commend this Committee, and the House of Representatives, for this year adopting a reauthorization of the Competes Act that builds on the initial legislation. The bill you passed would not only improve STEM education efforts to help prepare students for the highly technical jobs of the future, but would keep us on the path towards efforts to develop transformational new energy technologies. These goals are too important to be abandoned and I encourage the Senate to follow in your footsteps and pass the America Competes reauthorization before this Congress comes to an end.

The responsibility to better prepare our students for careers in the STEM fields falls not just to the government, of course, but to the private sector as well. As you may be aware, I recently accepted the challenge of serving as Chair of an important initiative called "Change the Equation." Change the Equation is a private sector effort comprised of over 100 companies from all different industry sectors and from all across the country. We aim to improve STEM education by:

1. Improving STEM teaching at all grade levels.
2. Inspiring student appreciation and excitement for STEM programs and careers.
3. Achieving a sustained commitment to improving STEM education from business leaders, government officials, STEM educators and other stakeholders through innovation, communication, collaboration and data-based decision making.

Change the Equation will work with our member companies to identify education programs that are successful and spread them to more than 100 sites across the country. We are also going to assess STEM education efforts in the 50 States by building a scorecard to measure their performance. And we are going to disseminate principles for how businesses can help to improve STEM education.

We know that STEM literacy is a business imperative for our nation's economic excellence, success and citizenship. Our collaboration will not only help students, but will revive our economy, fuel our industries, strengthen our democracy and ultimately empower our nation.

Every year reports are produced that say the same thing. We need action. A recent report projected that by 2018 there will be eight million jobs in STEM-related fields. However, the report also indicates that the next generation of employees in America will be unprepared and unqualified to take advantage of these positions.

A follow up report to Gathering Storm highlights the many challenges we still face. It found that:

- Sixty-nine percent of United States public school students in fifth through eighth grade are taught mathematics by a teacher without a degree or certificate in mathematics.
- Only four of the top ten companies receiving United States patents last year were United States companies.
- United States consumers spend significantly more on potato chips than the government devotes to energy R&D.

America has an innovation problem. And we need to solve it. The America Competes Act of 2007 took steps towards tackling this problem and the reauthorization of the Act this year would signal continued Congressional support for making the investments we must make.

But to truly benefit from America's renewed commitment to basic research, and to provide American students the STEM skills they need to keep America competitive, we need both the government and the private sector to further increase their efforts and make the hard choices required—investing in our students, in our schools, and in the creation of new job opportunities by removing barriers to innovation.

The commitment of the private sector and the support of government are both essential to ensure that American remains competitive in the global marketplace. While it is incumbent upon U.S. businesses to make smart investments in the technologies they pursue and the people they hire, it is equally important that the government adopt policies that give American industry a competitive advantage.

Finally, Mr. Chairman, as you will be retiring at the end of this Congress, I want to express my appreciation to you for your 26 years of service to our nation. You have always been one of the most passionate advocates for investment in science, basic research, STEM education and all of the keystones of innovation that are so critical to our future.

Thank you again, Mr. Chairman, for the opportunity to testify before you today. I look forward to answering any questions you may have.

BIOGRAPHY FOR CRAIG BARRETT

Dr. Craig Barrett is a leading advocate for improving education in the U.S. and around the world. He is also a vocal spokesman for the value technology can provide in raising social and economic standards globally. In 2009, he stepped down as Chairman of the Board of Intel Corporation, a post he held from May 2005 to May 2009.

Craig Barrett was born in San Francisco, California. He attended Stanford University in Palo Alto, California from 1957 to 1964, receiving Bachelor of Science, Master of Science and Ph.D. degrees in Materials Science. After graduation, he joined the faculty of Stanford University in the Department of Materials Science and Engineering, and remained through 1974, rising to the rank of Associate Professor. Dr. Barrett was a Fulbright Fellow at Danish Technical University in Denmark in 1972 and a NATO Postdoctoral Fellow at the National Physical Laboratory in England from 1964 to 1965. He is the author of over 40 technical papers dealing with the influence of microstructure on the properties of materials, and a textbook on materials science, *Principles of Engineering Materials*.

Dr. Barrett joined Intel Corporation in 1974 and held positions of vice president, senior vice president and executive vice president from 1984 to 1990. In 1992, he was elected to Intel Corporation's Board of Directors and was promoted to chief operating officer in 1993. Dr. Barrett became Intel's fourth president in 1997, chief executive officer in 1998 and chairman of the Board in 2005.

Dr. Barrett served until June 2009 as Chairman of the United Nations Global Alliance for Information and Communication Technologies and Development, which works to bring computers and other technology to developing parts of the world. He co-chairs Achieve, Inc., is vice chairman of the National Forest Foundation, president and chairman of the BASIS School, Inc. Board of Directors, and a member of the Board of Directors of Society for Science and the Public, Science Foundation Arizona, and Dossia. Dr. Barrett serves on the advisory board of the Peter G. Peterson Foundation, the Arizona Commerce Authority Board, the faculty of Thunderbird School of Global Management, and is Honorary Chairman of the Irish Technology Leadership Group. Recently, Dr. Barrett has been appointed by the President of the U.S. as one of the private sector leaders for a national education science, technology, engineering and math (STEM) initiative now known as *Change The Equation*, and he has been appointed by the President of the Russian Federation as the International co-chairman to lead the Board of the Fund for Development of the Center for Elaboration and Commercialization of New Technologies. Dr. Barrett has served

on numerous boards, policy and government panels, and has been an appointee of the President's Advisory Committee for Trade Policy and Negotiations and the American Health Information Community. He has co-chaired the Business Coalition for Student Achievement and the National Innovation Initiative Leadership Council, and has served as a member of the Board of Trustees for the U.S. Council for International Business and the Clinton Global Initiative Education Advisory Board. Dr. Barrett has been a member of the National Governors' Association Task Force on *Innovation America*, the National Infrastructure Advisory Council, the Committee on Scientific Communication and National Security, the U.S.-Brazil CEO Forum, past chair of the National Academy of Engineering, and formerly served on the Board of Directors of the U.S. Semiconductor Industry Association, the National Action Council for Minorities in Engineering, and TechNet.

Chairman GORDON. Thank you. Mr. Holliday.

STATEMENT OF CHARLES HOLLIDAY, JR., CHAIRMAN OF THE BOARD OF BANK OF AMERICA AND RETIRED CHAIRMAN OF THE BOARD AND CEO OF DUPONT

Mr. HOLLIDAY. Thank you, Mr. Chairman, and we appreciate your strong leadership in this regard.

I have a very specific idea to leave with you today that takes the work of this committee to the next step, an idea around low-cost, clean energy. We believe if we could create that in this country, we could do a lot to move those statistics that Norm described in a very different way.

And Norm Augustine and myself gathered with other people from companies that have a track record of making a step change in technology. Ursula Burns from Xerox. We don't call it the Xerox machine for nothing. John Doerr, who is critical in funding so many of the iconic companies now on the west coast; a guy named Gates who has done some things around software; Jeff Immelt from General Electric; and Tim Solso from Cummins—and they have done amazing things to take the diesel engine to a different area.

We said if we were in charge of creating that low-cost, clean energy, how would we do it, and we wrote a business plan, which I would be glad to give you a copy of. And I will just share with you the five very simple recommendations.

We said we think this is possible, but it is going to take some time. It may take a decade, it may take more, and we need continuity over that period of time, and we need a board, a strategy board responsible to you that is consistent over a period of time and doesn't change every two to four years. And we believe that is possible. That is how we would do it inside our company.

Second, we must fund it to win. The amount of money being spent today is important. It is not enough in our estimation. To get there we think we need \$11 billion more dollars. We think it is one of the best investments our country could ever make to create the kind of jobs we need over time.

Then we looked at what we have been very successful at in this country, and that is creating clusters of technology and business together; that is where our big breakthroughs have come. We recommended doing that again. We did not say which technologies. We want the market to pick those. We did not say in which cities or what universities they should be tied with, but we think that is a model that is uniquely American and should be taken forward.

Something in *America COMPETES* that has worked very, very well is ARPA-E. It is this concept of funding entrepreneurs early

on with big-step change projects. I was out meeting with the Department of Energy people on this very subject just three weeks ago, went project by project, and you would be very proud of what they are doing. The quality of people that Steve Chu and his team have attracted, but also the projects. They meet that requirement. When they are successful, they will be really low cost and really clean energy. They have 37 of them. They all won't be a success. If we could just get three or four of them to be a success, that would be a breakthrough.

Our last recommendation is absolutely critical. We found that in all of our work with the National Academies, you can't have a great technology but let it sit on the shelf, let it sit on the lab bench, and from all of our experience in the seven companies that we're involved in, we all have prototype facilities. We knew we could not go from the lab to scale subtly. So we had to have a prototype facility necessary.

Because of the very high cost of this kind of investment, individual companies will not make that. So we think assistance from the Federal Government in those prototype facilities is critical, and this strategy board I described in recommendation number one is the mechanism for handling that.

So we left this work extremely encouraged. We think we could put a significant amount of money—we are not minimizing what \$11 billion is, but we believe \$11 billion per year over a decade can step change our position, and we hope you will consider it.

Thank you very much.

[The prepared statement of Mr. Holliday follows:]

PREPARED STATEMENT OF CHARLES HOLLIDAY, JR.

Good morning Chairman Gordon and Members of the Committee. As you well know, I was involved in the original *Gathering Storm* report. That report made specific policy recommendations on four areas critical to American competitiveness:

- Vastly improve K–12 science and mathematics education.
- Sustain and strengthen the nation's commitment to long-term basic research that has the potential to be transformational.
- Make the United States the most attractive setting in which to study and perform research. Attach a green card to the diploma for international students who pursue higher education in science, technology, engineering or math here in the United States.
- Ensure that America is the premier place in the world to innovate; invest in manufacturing and marketing; and create high-paying jobs based on innovation.

I will let my esteemed colleague, Norm Augustine, describe the details of that report and the related progress we've made on those issues in more detail. Instead, I will focus my remarks on a subsequent effort that Mr. Augustine and I were involved with focusing on energy innovation. So, I speak to you today on behalf of the American Energy Innovation Council (AEIC), which is comprised of a group of America's top business executives who came together earlier this year to recommend ways to promote American innovation in clean energy technology. Today, I will discuss why America must invest in clean energy innovation and how we can achieve a more productive national energy innovation system that will improve our prosperity, our security and our environment. In particular I will describe the five recommendations from our recent report, "*A Business Plan for American Energy Innovation.*"

Indeed, technology innovation—especially in energy—is at the heart of many of the central economic, national security, competitiveness and environmental challenges facing our nation and I commend the Committee on Science and Technology, and especially Chairman Gordon, for the thoughtful consideration they are giving these issues.

Before discussing the specific recommendations of our report, I'd like to say a little more about the American Energy Innovation Council and how we came together. The AEIC was launched in January 2010 and, in addition to myself, its members include: Norm Augustine, former Chairman and Chief Executive Officer of Lockheed Martin; Ursula Burns, Chief Executive Officer of Xerox; John Doerr, Partner at Kleiner Perkins Caufield & Byers; Bill Gates, Chairman and former Chief Executive Officer of Microsoft; Jeff Immelt, Chairman and Chief Executive Officer of General Electric; and Tim Solso, Chairman and Chief Executive Officer of Cummins Inc. During our report deliberations, the AEIC was advised by a Technical Review panel consisting of preeminent energy, science and innovation experts.¹ The AEIC is supported, funded and staffed by the Bipartisan Policy Center and the ClimateWorks Foundation.² This group coalesced around the mission to foster strong economic growth, create jobs in new industries, and reestablish America's energy technology leadership in the development of clean energy technologies.

As business leaders, my AEIC colleagues and I have had the great privilege of building companies that lead our respective fields and employ hundreds of thousands of American workers. Our experience has given each one of us an unshakable belief in the power of innovation. Each of our companies achieved prominence because we invested heavily and steadily in new ideas, new technologies, new processes and new products. Indeed, innovation is the essence of America's economic strength, and it has been our nation's economic engine for centuries. Our leadership in information technology, medicine, aviation, agriculture, biotech and dozens of other fields is the result of our enduring commitment to innovation.

The AEIC, however, came together around the belief that in energy investment—a realm central to America's economic, national security, and environmental future—our commitment to innovation is sorely lacking. Investment in energy innovation, from both the public and private sectors, is paltry—less than one-half of one percent of the national energy bill—and this neglect carries serious consequences.

Due to our constrained energy technology options, our economy is vulnerable to price shocks—in oil, natural gas, and even electricity. The United States sends about \$1 billion overseas every day for imported oil, expenditure that represents the biggest part of the trade deficit and often causes economic hardship for American consumers and businesses. Our foreign oil reliance undermines national security by enriching hostile regimes while our military forces are often deployed to protect access to oil. And the environmental costs of limited clean energy options are steep and growing, with both conventional pollution and climate change harming human health, threatening lives and livelihoods, and imperiling the natural systems upon which we rely for food, water, and clean air. The scale of these threats, and the wealth of opportunities to do better, make the message clear: it is time to invent our future.

We must make a serious commitment to the goal of modernizing our energy system with cleaner, more efficient technologies. Such a commitment should include both robust, public investments in innovative energy technologies as well as policy reforms to deploy these technologies on a large scale. I joined with my AEIC colleagues to address ways we believe the United States can better meet this commitment.

Although the private sector will be paramount in commercializing and deploying clean energy on a national scale, it cannot achieve this goal alone. The fundamental differences between energy and most other economic sectors limit the ability of the private sector to solve large-scale energy problems on its own. For instance, national security, national economic strength, and the environment are not primary drivers for private sector investments, but they are critical to the health of our country. Large scale deployment of many new energy technologies requires massive capital expenditures that are often too risky for private investors, and the product—electricity—is sold into a generic market that does not differentiate between clean and dirty sources. Additionally, America's long-term corporate R&D budgets, especially those run by utilities, have been in decline for several decades. Finally, the turnover of our energy infrastructure—particularly in the electrical generation system—is very slow.

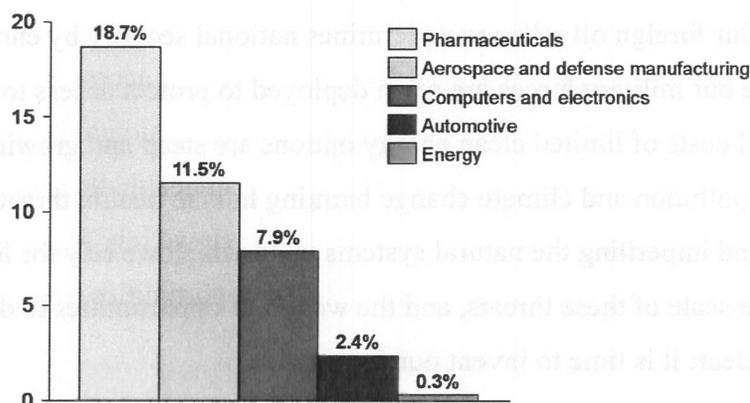
Add these elements together, and it becomes clear why private sector investments in clean energy technology development have been so small. In fact, of all major

¹A list of the Technical Review Panel can be found at the end of the document.

²More information about the Bipartisan Policy Center and the ClimateWorks Foundation can also be found at the end of this document.

technology-dependent sectors, the energy sector spends the smallest portion of its sales on research and development.³

R&D spending as a share of gross sales



The government must therefore act to spur investments in energy innovation and mitigate risk for large scale energy projects. After drawing on the large body of work and experts in the field of innovation, taking a hard look at what has worked to promote innovation in defense, medicine, information technology and other fields, and calling upon our experience managing large innovation programs in our companies, we developed five recommendations to spark a similar federal commitment to energy innovation. By heeding these recommendations, we believe the United States can unleash our energy technology potential and mobilize the private sector to join in the effort.

Recommendation 1: Create a national Energy Strategy Board

Mr. Chairman, the United States does not have a realistic, technically robust, long-term national energy strategy. Without such a strategy, there is no way to assess the effectiveness of energy policies, nor is there a coherent framework for the development of new energy technologies. The result of this neglect is reflected in our nation's history— with oil-driven recessions, environmental degradation, trade deficits, national security problems, increasing CO₂ emissions, and a deficit in energy innovation.

We recommend the creation of a congressionally mandated Energy Strategy Board charged with (1) developing and monitoring a National Energy Plan for Congress and the executive branch, and (2) oversight of a New Energy Challenge Program (see Recommendation 5). The Board should be external to the U.S. government, should include experts in energy technologies and associated markets, and should be politically neutral.

Recommendation 2: Invest \$16 billion per year in clean energy innovation

In order to maintain America's competitive edge and keep our economy strong, the United States needs sizable, sustained investments in clean energy innovation. The challenge must be met head on, and we believe that \$16 billion per year— an increase of \$11 billion over current annual investments of \$5 billion— is the minimum level required. This funding should be set with multi-year commitments, managed according to well-defined performance goals, focused on technologies that can achieve significant scale, and be free from political interference and earmarking.

³(1) National Science Foundation Data table 36. Federal research and development obligations, budget authority, and budget authority for basic research, by budget function: FY 1955–2009. http://www.nsf.gov/statistics/nsf08315/content.cfm?pub_id=3880&id=2

(2) G.F. Nemet, D.M. Kammen, *U.S. energy research and development: Declining investment, increasing need, and the feasibility of expansion*, Energy Policy 35 (2007) 746–755.

(3) Pharmaceutical Research and Manufacturers of America (PhRMA), Pharmaceutical Industry Profile 2008. Washington DC. <http://www.phrma.org/files/attachments/2008%20Profile.pdf>

(4) Science and Engineering Indicators 2010, National Science Foundation, www.nsf.gov/statistics/seind10/pdf/c04.pdf

I must note that this second recommendation is critical to the success of any real effort to jump start any energy innovation efforts. Even in a time of constrained budgets, bold action is required. Our other recommendations will not matter much if sufficient funding is not realized. Reliance on incrementalism will not do the job.

Recommendation 3: Create Centers of Excellence in energy innovation

In other high-tech fields, critical technologies have achieved large-scale market success through multi-disciplinary collaboration between the private and public sectors. Technology innovation requires expensive equipment, well-trained scientists, multi-year time horizons and flexibility in allocating funds. This can be done most efficiently and effectively if the institutions engaged in innovation are located in close proximity to each other, share operational objectives and are accountable to each other for results.

To provide the above attributes to the energy industry, we recommend the creation of national Centers of Excellence in energy innovation. The Department of Energy's newly created Energy Innovation Hubs are a good start at such centers, but are not sufficiently funded to achieve the desired results. Additional Centers of Excellence need to be supported, with recommended annual budgets of \$150 to \$250 million each. To function effectively and deliver results, each of these Centers will need the flexibility to pursue promising developments and eliminate dead-end efforts.

Recommendation 4: Fund ARPA-E at \$1 billion per year

The creation of the Advanced Research Projects Agency-Energy (ARPA-E) has provided a significant boost to energy innovation. ARPA-E focuses exclusively on high-risk, high-payoff technologies that can change the way energy is generated, stored, and used; it has challenged innovators to come up with truly novel ideas and "game changers." The program has high potential for long-term success, but only if it is given the autonomy, budget, and clear signals of support to implement needed projects. It will need long-horizon funds on a scale commensurate with its goals, and a life extension beyond the current federal stimulus. We recommend a \$1 billion annual commitment to ARPA-E.

Recommendation 5: Establish and fund a New Energy Challenge Program to build large-scale pilot projects

America's energy innovation system lacks a mechanism to turn large-scale ideas or prototypes into commercial-scale facilities. We recommend the creation of a New Energy Challenge Program to fund, build and accelerate the commercialization of advanced energy technologies— such as 4th generation nuclear power or carbon capture and storage coal plants.

This program should be structured as a partnership between the federal government and the energy industry, and should operate as an independent corporation outside of the federal government. It should report to the Energy Strategy Board (see Recommendation 1) and focus on the transition from pre-commercial, large-scale energy systems to integrated, full-size system tests. The public sector should initially commit \$20 billion to the Program over 10 years through a single federal appropriation, which would unleash significant private sector resources as particular projects are developed.

Conclusion

In addition to our specific recommendations, I'd also like to note that successful energy innovation programs have three prerequisites: the first is a pipeline of new inventions; the second is a suite of policy reforms that will stimulate market demand for these new inventions; and the third is a highly skilled workforce with the ability to create and deploy these inventions. The plan put forth above addresses the first and provides a strategy to fill the American energy innovation pipeline with new technologies designed to deliver a more secure, sustainable future.

However, we recognize that research, development, and deployment all need complementary energy policies to advance innovation and drive market adoption of new technologies. Innovation without implementation has no value. A strong market signal will increase the intensity of energy research, add large private-sector commitments, reduce barriers between the lab and market, and ensure technologies perform better and cost less over time. Those policies may include some combination of a price or cap on CO₂, a clean energy or renewable energy portfolio requirement, or technology performance standards.

In sum, I come before the Committee today with a challenge, but also with a sense of optimism. In the defense, health, agriculture, and information technology

industries, this country has made a deliberate choice to use intelligent federal investments to unleash profound innovation. As a result, our country leads in all those realms. In energy, however, the country has failed the grade, and is paying a heavy price for that failure. We must change this course.

The good news is that if the United States invests in its clean energy future now, our nation can reap immense benefits. The members of the AEIC are optimistic about the potential for dramatic change in the energy realm. As business leaders, we know how the private sector can be mobilized to attack these problems, but we also know that the government must step up to protect the public interest. We have seen this work in other sectors, and know it can work in the energy sector, as well. Public- and private-sector innovators have made miracles happen right here on home soil— Americans developed the computer and the internet, delivered air and space travel, and decoded the human genome. The same transformations can happen in energy.

In closing, we are convinced that America has a great deal to gain from smart, ambitious investments in clean energy innovation. The recommendations laid out above are specific and affordable. They set forth the necessary actions that the public sector must take to unlock the ingenuity and capital of the American marketplace in pursuit of the nation's clean energy goals. To seize this opportunity, America must put aside partisan interests and make a strong, bold commitment. We challenge Congress, and indeed the country, to make this commitment. By tapping America's entrepreneurial spirit and long-standing leadership in technology innovation, we believe our country can set a course for a prosperous, sustainable economy— and take control of our energy future.

Thank you for the opportunity to testify before the Committee today.

The American Energy Innovation Council (AEIC) Technical Review Committee:

- **Chair**—Maxine Savitz, former General Manager of Technology Partnerships at Honeywell; member of the President's Council of Advisors on Science and Technology; Vice President, National Academy of Engineering
- Ken Caldeira—Department of Global Ecology, Carnegie Institution of Washington
- David Garman—Former Under Secretary of Energy and Assistant Secretary of EERE at DOE
- Rebecca Henderson—Senator John Heinz Professor of Environmental Management, Harvard Business School
- David Keith—Professor and Director of ISEEE Energy and Environmental Systems Group at the University of Calgary
- Richard Lester—Director of the Industrial Performance Center and Professor and Head of the Department of Nuclear Science and Engineering at MIT
- Nate Lewis—George L. Argyros Professor of Chemistry at the California Institute of Technology
- Ernie Moniz—Cecil and Ida Green Professor of Physics and Engineering Systems and Director of the MIT Lab for Energy and Environment and of the MIT Energy Initiative, MIT; member of the President's Council of Advisors on Science and Technology
- Franklin Orr—Professor, Stanford University
- Allen Pfeffer—Vice President of Technology, Alstom Power
- Dan Sarewitz—Director, Consortium for Science, Policy, and Outcomes, Arizona State University
- Chuck Shank—former Director of Lawrence Berkeley National Laboratory

About the Bipartisan Policy Center

In 2007, former U.S. Senate Majority Leaders Howard Baker, Tom Daschle, Bob Dole and George Mitchell formed the Bipartisan Policy Center (BPC) to develop and promote solutions that can attract the public support and political momentum to achieve real progress. Currently, the BPC focuses on issues including health care, energy, national and homeland security, transportation, science and economic policy. For more information, please visit www.bipartisanpolicy.org

About the ClimateWorks Foundation

The ClimateWorks Foundation supports public policies that prevent dangerous climate change and catalyze sustainable global prosperity. The ClimateWorks network

includes partner organizations across the world, aligned to support smart policies in the regions and sectors that have the greatest potential for reducing greenhouse gas emissions. For more information, please visit www.climateworks.org

BIOGRAPHY FOR CHARLES HOLLIDAY, JR.



Charles O. Holliday, Jr. is chairman of the board of directors of Bank of America. He has served as a director since September 2009. He is the former chairman of the board of directors of E.I. du Pont de Nemours and Co., a position he had held for approximately 10 years. He served as chief executive officer of DuPont from 1998 until 2008. He joined DuPont in 1970 as an engineer and held various positions throughout his tenure.

Since 2007, Holliday has served as a member of the board of directors of Deere & Co. and as a member of the board's audit and corporate governance committees. He is chairman emeritus of Catalyst, a leading nonprofit organization dedicated to expanding opportunities for women and business, and chairman emeritus of the board of the U.S. Council on Competitiveness, a nonpartisan, nongovernmental organization working to ensure U.S. prosperity.

Holliday is a founding member of the International Business Council and a member of the National Academy of Engineering. He also previously served as chairman of the following organizations: the Business Roundtable's Task Force for Environment, Technology and Economy, the World Business Council for Sustainable Development, The Business Council, and the Society of Chemical Industry—American Section.

He received a bachelor's degree in industrial engineering from the University of Tennessee and received honorary doctorates from Polytechnic University in Brooklyn, New York and from Washington College in Chestertown, Maryland.

Chairman GORDON. Thank you, Mr. Holliday.

I will point out in the *America COMPETES Act* we do have a cluster program where we can bring those folks together. I think it is understood now that there is not that single—or rarely it is that single inventor 'eureka' moment, but rather it is the collaboration of those folks working together on a topic.

And Dr. Dan Mote is now recognized. Dr. Mote, you need to hit your mic there, please.

**STATEMENT OF C.D. (DAN) MOTE, JR., PRESIDENT EMERITUS
OF THE UNIVERSITY OF MARYLAND AND GLENN L. MARTIN
INSTITUTE PROFESSOR OF ENGINEERING**

Dr. MOTE. Thank you very much. I apologize. I thank you for this opportunity to make a few remarks.

Well, first I would just comment that there is no question that the country has made progress on its support for science and tech-

nology since 2005, through the *America COMPETES Act* and other initiatives, ARRA funds and STEM education initiatives and the like. National awareness is higher now than it was then, and “*Rising Above the Gathering Storm*” has become a household phrase in many places. And remarkably it has legs five years later, which is, in and of itself, critical.

But as in the revisited report, the category five report that has come out, the United State is relatively less competitive globally today than it was in 2005, probably for three reasons.

One is the report was not fully implemented in an ongoing manner when it started. Second is other countries have engaged rather aggressively, both those that weren’t engaged then and those that were then, in a very determined and purposeful manner. And thirdly and possibly most importantly, our country has many national priorities today; wars, national debt, sluggish economy, unemployment, housing, healthcare, terrorism, and so on, and global competitiveness in S&T and innovation is really not near the top in priority among them. That is a very principal problem for us.

If we believe delivering high-quality, high-paying jobs for Americans depends on competitiveness and innovation in science and technology, then it should be a high priority today.

I recently chaired a National Research Council committee that studied the science and technology strategies of six countries and their implications for the United States. Those—and that has now been printed, as a matter of fact—the six countries are Japan, Brazil, India, Russia, China, and Singapore. Now, the countries individually were studied in great detail in terms of why they are succeeding and what their priorities are and how they are progressing, and there are a couple of findings on the countries themselves and then overall findings as a group.

The study concluded—I think surprisingly for the Members of the Committee, but very importantly—that the best predictor of future science and technology competitiveness was the national culture. While we commonly use economic and capacity measures to rate S&T innovation capabilities, things like percentage of GDP going for research or number of engineering graduates, it turns out that the countries that shape their cultures to facilitate their goals receive—achieve them predictably and will likely do so in the future.

Of the six countries studied, Singapore and China stood out in this regard. While these two countries have remarkably different goals, different drivers of science and technology innovation, different population scales to say the least, different markets, they use similar strategies in shaping their cultures to focus on S&T priorities. Essentially culture and S&T priorities went hand in hand. And they also experienced similar achievements. And we could go into some detail about how that was done if we had some time.

However, the other four countries, that is, Japan, Brazil, India, and Russia, have been actually held back strikingly in their S&T achievements because of cultural issues that have limited the priority they would afford their S&T goals.

Japan is a good example, just very quickly. How is Japan held back? No women in the workforce; it is a country that is reluctant

to welcome international people to work in its labs; no immigration; universities don't work with industry. You can go down through Japan, and there are a number of cultural issues which have essentially inhibited its advancement. And of course, it has been in the doldrums for two decades, as we all know.

So when the national security of the United States is threatened, such as after 9/11 or Sputnik and so forth, our Nation has abruptly changed its culture to support a national security priority. However, these occasions are, fortunately, rare, but they are also widely recognized as requiring national security priority.

But if we do not recognize the significance of the declining course of U.S. competitiveness in science and technology and innovation, our future prosperity and national security basically will not—we will not change our S&T priority [as] needed to fix this problem. Actually, I believe that is where we are today. We do not see, as a Nation, that this is a critical problem.

I also believe it would be instructive for those in policy-making positions to visit China and Singapore to gain a first-hand understanding of why they are succeeding and what changes in culture they have actually instituted, at some cost to themselves, to achieve this success. I am confident this would be a stunning experience for all who went there. I think only then would we fully understand the seriousness of our national competitiveness problem and the priority attention that we really need to apply to this to fix it.

Thank you.

[The prepared statement of Dr. Mote follows:]

PREPARED STATEMENT OF C.D. MOTE, JR.

Chairman Gordon and members of the House Committee on Science and Technology. I appreciate the opportunity to comment on "Rising Above the Gathering Storm, Revisited" and its implications. I will be mindful of your time in making a few take-away points.

First, there is no question that the country has made progress in supporting Science and Technology (S&T) since the "Rising Above . . ." report in 2005 through the America Competes Act, ARRA, STEM education initiatives and the like. National awareness of our competitiveness in innovation has increased, Rising Above the Gathering Storm has become a household phrase, and remarkably, it has "legs" today, five years hence. But, regrettably, as this "Rising Above . . . Revisited" report vividly verifies, the United States is relatively less competitive globally today than it was in 2005 for two principal reasons: (1) we did not implement sufficiently and in an on-going manner the recommendations in the earlier report, and (2) other countries have continued their advances in S&T competitiveness with determination and purpose. Also our national priorities today are many (e.g., wars, debt, economy, jobs, housing, healthcare, terrorism) and global competitiveness in S&T and innovation is not near the top among them. This is our principal and fundamental problem.

If we believed that delivering high quality, high paying jobs for Americans depends on our competitiveness in innovation, science and technology, S&T competitiveness would have very high priority today.

I recently chaired the ad-hoc National Research Council "Committee on Global Science and Technology Strategies and Their Effect on U.S. National Security." This committee issued a 2010 report titled the "S&T Strategies of Six Countries: Implications for the U.S." [<http://www.nap.edu/catalog/12920.html>]. The six countries are Japan, Brazil, Russia, India, China, and Singapore—JBRICS. This study concluded that national culture was the "best predictor" of future S&T competitiveness. Most countries, including the U.S., use economic and capacity measures to rate S&T innovation capability, for example, %GDP invested in research or number of engineers graduating from universities. However, those countries that shape their cultures to facilitate the achievement of their priority S&T goals have predictably succeeded in

reaching those goals, and will likely do so in the future. Of the six countries studied, Singapore and China stood out in this regard. While these two countries have remarkably different goals, different drivers of S&T and innovation, different population scales, and different markets, they used similar strategies in shaping their cultures to focus on S&T priorities. And they experienced similar achievements against their goals. However, the other four JBRIC countries (Japan, Brazil, Russia and India) have been held back strikingly in their S&T achievements because cultural issues have limited the priority they afforded their S&T goals. The committee concluded that their future achievements will likely be similarly limited unless changes in cultural priorities are forthcoming. Culture has been largely overlooked when predicting national innovation capacity.

When the national security of the U.S. was acutely threatened by the attacks of September 11, the nation abruptly changed its culture to support the national security priority. However, such occasions are rare and widely recognized as national emergencies requiring unusual actions. If we do not recognize the significance of the declining course of U.S. competitiveness in S&T and innovation to our future prosperity and national security, we will not change the culture necessary to make S&T a higher priority. I believe this is where we are today.

I strongly encourage leaders in U.S. policy-making positions to visit China and Singapore to gain a firsthand understanding of why they are succeeding and what changes in culture they have instituted to achieve their goals. I am confident that this would literally be a “stunning experience” for all those participating. Only then will we fully understand the seriousness of our national competitiveness problem and the priority attention required today to fix it.

BIOGRAPHY FOR C.D. MOTE, JR.

C. D. (Dan) Mote, Jr. began his tenure as president of the University of Maryland and Glenn L. Martin Institute Professor of Engineering in September 1998. As President from 1998–2010, he encouraged an environment of excellence across the University, and provided leadership in implementing its 10-year strategic plan to elevate Maryland into the top tier of research universities worldwide.

Academic programs flourished under Dr. Mote with the University ranking 18th among U.S. public universities according to *U.S. News & World Report* and 37th in the world according to the Academic Ranking of World Universities by Shanghai’s Jiao Tong University.

Dr. Mote sought to draw more of the State’s highest-achieving students by expanding honors programming, living and learning communities and establishing the President’s Promise, which offers every undergraduate the opportunity for a unique experience outside the classroom. He also launched the Maryland Incentive Awards Program in 2001 to recruit and provide full support to Baltimore and Prince George’s County high school students of outstanding potential who have overcome extraordinary adversity.

Dr. Mote also spurred the University to become one of the State’s most valuable economic engines, with a \$3.4 billion annual impact. The University’s research, outreach and education assist the State by bringing major federal and private partners to the area’s largest research park, M Square, growing small businesses, and graduating the State’s largest number of scientific, business, life science, engineering and technology students. He worked to strengthen the University’s position as a global institution, overseeing substantial growth in international partnerships, creating an international incubator, study abroad programs, recruitment of international undergraduates, and programs for training international government and business leaders. Under Dr. Mote’s leadership, the University addressed today’s most pressing scientific and societal challenges, such as climate change, the economy, energy, homeland security and public health. Its research enterprise raised \$550 million in external grants and contracts in fiscal year 2010.

Dr. Mote serves on National Academy of Sciences (NAS) committees that address challenges to U.S. leadership in science and technology, including the committee that authored the *Rising Above the Gathering Storm* report. He co-chairs The Academies Government-University-Industry-Research Roundtable and is a member of its Committee on Science, Engineering and Public Policy. He is a member and Treasurer of the National Academy of Engineering, where he serves on its Council and is a Steering Committee member of the Energy Security, Innovation and Sustainability Initiative of the Council on Competitiveness.

Dr. Mote previously served for 31 years on the faculty of the University of California, Berkeley, where he earned his three engineering degrees, served as vice chancellor, held an endowed chair in mechanical systems and was president of the UC Berkeley Foundation. He conceived and led a comprehensive capital campaign

for Berkeley that raised \$1.4 billion. He earlier served as chair of Berkeley's Department of Mechanical Engineering.

Chairman GORDON. Thank you, Dr. Mote.

We will now begin our first round of questions, and I recognize myself for that first five minutes.

To the three former CEOs: you each ran major corporations. Dr. Barrett pointed out that you had a research budget bigger than NSF. Now that you are retired, have your Social Security, and paying taxes like the rest of us, you know, why should we taxpayers subsidize public research for major corporations?

Dr. Barrett.

Dr. BARRETT. I frankly don't think the U.S. government and the taxpayers should subsidize research within the private corporations unless the government has a specific project or objective, such as if you would want to create an X-scale computer for government activity and future research. The request is really to fund research in the virtual 'National Laboratory' of the United States—which is, in fact, the tier one research institutions—is to fund basic research, pre-competitiveness research, research which is probably at least eight to ten years from any competitiveness introduction. That research is not funded by corporations to any great degree for a variety of reasons. It is carried out in universities and the public environment that the public has great access to.

So the demand or the request is not to fund research within corporations. It is really to fund research within the U.S. research universities, pre-competitiveness research, research that might create products, services, new companies, but far in advance, not the sort of research that an Intel and IBM, DuPont, Lockheed Martin would do, which is directed towards products of tomorrow or within a few years.

Chairman GORDON. Anyone else want to—Mr. Holliday?

Mr. HOLLIDAY. I agree totally. I would just add a short vignette. I was at the DuPont annual patent dinner sitting next to an individual who was winning his 100th patent that night, and he was talking about how we had moved our research effort toward more applied, more applications and less basic. And he was cautioning me about the problem of that. My answer was, we must depend on the universities to provide that basic research for us and our competitors. And he said, but what if those universities aren't there to do it?

And so that is really what we are talking about today, is that basic research that must be at the university level. It is better done at the university level, or the National Labs, so all competitors can have access to it and compete to make it a success.

Chairman GORDON. Mr. Augustine.

Mr. AUGUSTINE. Yes. I would be opposed to the government subsidizing work or activities at a company that could lead to a predictable impact on the individual company's profitability. I would also note that a few decades ago 2/3rds of the R&D in this country was funded by the government and only 1/3 by industry. Today industry funds 2/3rds and the government 1/3. The problem is that industry largely funds the "D," and the problem that we are, of course, discussing in the hearing is "R": research, basic research.

Basic research has a couple problems that make it not very amenable for work by industry. One of these is that the benefits of basic research often don't accrue to the performer or the underwriter of the research being performed because of the unpredictability of the applicability of research.

That, sort of, is the basic category of things where the government generally steps in and provides that service—of running an education system, providing national security, and so on.

The second feature of basic research is it is very long-term, very high-risk, and in many cases very expensive. And those factors just don't lend themselves to the sort of things that the marketplace today will allow companies to invest in. With the great short-term emphasis of the markets, companies by and large are going to have to invest in shorter-term things, like development.

So it would seem to me that research is the province of government, [funding] development is a province of industry.

Chairman GORDON. And finally, Mr. Holliday, in your presentation you mentioned this business plan for America's energy future. You know, we have got healthcare problems, transportation problems, you know, feeding our public. There are lots of different areas. Why did you pick out energy?

Mr. HOLLIDAY. We saw that energy at a low cost could transform across the entire economy to make a difference. That was the one thing that we thought was about our national security, so we control it ourselves and really have a cost advantage to reinvigorate our manufacturing and the overall productive capacity of the country.

Chairman GORDON. Thank you, sir.

Mr. Hall is recognized for five minutes.

Mr. HALL. Mr. Holliday, I sure agree with you on the energy situation. For a youngster that is graduating from high school or college or beginning their life in the business world, probably the most important word in the dictionary other than 'prayer' for that set of young people is probably 'energy,' because energy is the cause of most wars or lack of energy is the cause of most wars, and Japan didn't hate us. They didn't bomb Pearl Harbor because they hated us. They bombed us because we cut them off of absolutely all of their oil. We were their sole supplier, and they had about maybe a year of national existence, so you could expect that to happen.

But I thank you for suggesting that because it reminded me again of yesterday.

Dr. Barrett, you alluded to keeping our jobs here and the good record that your company has of keeping the successes you have here on shore rather than send them offshore, and I think all of us appreciate that.

In your testimony, and along that line, I think of a parallel there that we all go through up here, because all of us appoint youngsters to the Academies, to West Point, to Navy, Air Force, and all that, and usually my board asks them if they are going to make it a lifetime work, you know. They have the right to, I think, at the end of four years, maybe five years, to come back into the business world, and I don't think that is altogether bad because they

bring the disciplines they learn there into the business world where discipline is really needed.

But it is similar to that, in your testimony—you discussed the importance of investing in research and development to promote new technologies, and you say once investments have been made in the new technologies and they are ready for the marketplace, what incentives are in place to ensure that the companies that reap the benefits of federal tax dollars for research and development will stay in the United States?

Well, how did you do it?

Dr. BARRETT. Well, I would—point of fact, I said that 75 percent of our manufacturing is still in the U.S., and that means 25 percent of it is outside. One of the reasons for that to date, if I could just digress for a moment: the net present value [NPV] of one of our multi-billion-dollar manufacturing facilities—there is a \$1 billion difference in its NPV if you put it in the United States or if you put it in a low-tax country. And the billion dollar NPV difference is really not related to wage rates. It is related to government incentives and tax rates.

The reason we have maintained our manufacturing facilities in the U.S. is we have a well-trained workforce in the United States. Time is of the essence. If you have to retrain a workforce to do a green field manufacturing plant some place else, you can lose valuable time.

There is no financial incentive to put those plants in the United States today. The financial disincentive is the U.S. tax rate. So what you are seeing is perhaps a lasting legacy of the fact that we started in the U.S., we have built up our major facilities in the U.S., we have a well-trained workforce in the U.S., we have continuity in the U.S., but if you start from scratch today, there is no incentive to put those plants in the United States.

Mr. HALL. Maybe you are before the wrong committee. Maybe you ought to go before Ways and Means.

Dr. BARRETT. Congressman Hall, I have been through every committee, every Administration, Democrat and Republican, every economic advisor, to every President with the same story, and we are still where we are.

Mr. HALL. I admire you for it, and I thank you.

I want to ask this additional question, though. Similarly, how do we insure that students who are being trained in the U.S. don't take their knowledge overseas? How can we keep those people here?

Dr. BARRETT. Well—

Mr. HALL. And those that come here seek to be citizens, to get their education and leave in degrees, all the universities all across the country, and then take their knowledge home.

Dr. BARRETT. Well over a decade ago I think we were the first to suggest that you should just simply staple a green card to every advanced degree, engineering, technology, mathematics, science degree obtainer, regardless of nationality. If they graduate from a U.S. university with an advanced degree, staple a green card to that diploma and let them stay.

There is no way to absolutely ensure that that knowledge base stays here. The way you ensure it is to, in fact, make the United

States the destination of choice for start-ups, the destination of choice for people who want to get a great education, but you have to have the visa issue, the immigration issue, and then the tax and incentive issues here to create start-ups and grow them.

Mr. HALL. I thank you, sir.

I yield back my time, Mr. Chairman. Thank you.

Chairman GORDON. Ms. Johnson is recognized.

I think over the last—or excuse me. I was wrong, Ms. Johnson. Ms. Edwards was here first. Each of you wins the attendance award for this session, and I thank you for that.

Ms. Edwards, you are recognized for five minutes.

Ms. EDWARDS. Thank you, Mr. Chairman.

I just have a question. First of all, I want to say on the, you know, the one point regarding research and development, I actually introduced last week H.R. 6201, the *21st Century Investment Act of 2010*, and part of the reason that I did that was really because of my experience in visiting small manufacturing facilities out in my Congressional district where they co-located the research and development that they were doing with the manufacturing they were doing. It was really important to have that manufacturing line really close to where the R&D was happening, and what we do in 6201—and I know that's not before this committee, though—is to actually incentivize and make permanent the research and development tax credit. It is one of the lowest among developed nations, in this country. Increase and make that permanent, and [H.R. 6201] also created a substantial tax credit that is an incentive for co-locating manufacturing.

When I talk to our manufacturers, what they say to me is that it is really important for them, both in terms of building and training their workforce but also then drawing on the local community, our local educational institutions, our local K–12, and establishing those relationships because they then know that that is the feeder ground for their manufacturing and for their research and development.

And so I'd urge you, Mr. Hall, take a look at that. But all of you, because I think that if we are talking about where we are going to go for the 21st century, we have to think not in pockets, but across the line from how we are creating the pipeline, obviously in K–12 and in our higher education institutions but then, you know, what is the employee base, and what do job creators need. I mean, they are going to do—if we invest in their innovation, what do they need, and right now I think there is not this sort of seamless line from our K–12 education and through our higher ed system into the workplace.

And so I appreciate your comments, Mr. Augustine, on this question of trying to create a seamless line from K–12 through the point when that young person goes into the workforce, and what is it that we can do to knit those together so that they are not in these individual strings?

And then if, Dr. Mote, I know that at the University of Maryland, and thank you for your service there, that your experience in working with our local scientific institutions in Maryland with our education institutions so that they feed into the workplace, and if you can do it in two minutes and 13 seconds, that would be great.

Mr. AUGUSTINE. Well, I think the business community has an obligation which it, I think, doesn't fully carry out today: to make very clear what are the skills it needs from a high school graduate. You pointed to that.

If one looks at college graduates, there is a significant problem of the gap between what skills and abilities and knowledge is required to get a high school diploma and what it takes to succeed as a freshman in college. And somehow we have got to close that gap. I would give that very high priority.

Dr. MOTE. Congresswoman Edwards, two things. One is in terms of the K-12 students, bringing them to the university for special programs, educational programs, research and laboratories that is a part of the mission of the university. And secondly, on the output end, we essentially guarantee internships for every student at the university. We have an office which basically creates internships, and in this area since there are so many internships in the area, it is fairly easy to accomplish this.

And so, therefore, we want to engage the students in the business communities and at various levels, but it also could be National Laboratories where these internships take place. So, I think, thinking of the university as a link to both the K-12 system and the jobs and post-graduate opportunities as well, is essentially the way we see ourselves. We see ourselves really as a most important asset that the state has in developing its future.

Chairman GORDON. Thank you, Ms. Edwards.

Ms. EDWARDS. Thank you.

Chairman GORDON. And Dr. Ehlers is recognized for five minutes.

Mr. EHLERS. Thank you, Mr. Chairman, and thank you very much for the panel for being here. I can't—you know, now that I am leaving here, I just want to commend you for—you have no idea how often I was trying to sell an idea in the Congress and not getting very far and then one or more of you would make a comment that was—supported what I was trying to do, and I could say, well, you know, so and so said this. "Oh, okay."

You know, Christ was right when he said a prophet is not without honor in the same assembly, and I found that over and over. I really appreciate what you have done for our country, and now that I am joining the ranks of the retired and unemployed, I hope I can contribute as much as you have.

I want to just get back to the question that was mentioned about what the Federal Government should pay for research in private corporations. I think a simple, straightforward answer is a very good healthy research and development tax credit, so the companies are still deciding what to study, what to do the research on. It is entirely their project, but at least let the Federal Government give them tax relief, because many of these are high-risk ventures, and corporations simply can't afford to do them if they don't get some assistance, preferably a tax credit.

I appreciate Mr. Holliday's comment about low-cost, clean energy. You are right on. That is totally correct, and that is something we all have to be working on and not just say, well, let the utilities take care of that. It is a much broader problem than that.

And Dr. Mote, you commented about—other nations are trying to catch up. We assume we are already there, and that is a fallacious belief in this country. The public, and I have given speeches all across the land, the public simply doesn't believe that there is a problem. They simply believe that we are on top, we are ahead of the pack, we have nothing to worry about, and the only reason other countries are making progress is because they have lower wage rates. They are totally wrong on that, and we have to educate them, but I can assure you from my many contacts with the public that this is the general attitude.

I would be delighted to see some of you running for Congress and taking my place. It is incredibly hard to persuade scientists and engineers to run for public office, and I have given, once again, given speeches to engineering and science groups across this country constantly urging them to run for office. It just doesn't happen.

Fortunately, since I arrived, the number of physicists have tripled, but we could certainly use a few more engineers as well to help in this task, and I really feel very guilty about retiring and leaving because it is not that I am so wonderful, it is just that the knowledge I have is badly needed here, and I hope the other two physicists grab hold of it and can take care of it.

But, really, we need much better representation here from the scientific and technical community if we are really going to accurately reflect and try to solve the Nation's problems in this area, whether it is education, whether it is patent law, so many different aspects of it. And it is a major part of our country's future, but it is not a major part of the agenda of either the House or the Senate.

Pardon me for giving you a sermon. I know you already believe all these things, but as I said before, I am the son of a preacher, and I can't get out without giving a sermon. But I really think that is the crux of it. Dr. Mote's problem of the people assuming everything is okay, that is because they are not hearing anything else from the Congress, from the Administration, and we really have to have the support of the people if we are going to do it.

So thank you so very much for what you are doing. You have been great leaders of this Nation on these issues, and I hope you will continue to do that, and I hope I can assist you once I am a private citizen again. Thank you very much.

Mr. HALL. Mr. Chairman, may I have just a minute?

I want to thank Dr. Ehlers, too, for his long service here, and I hope he never forgets what I told him the first week we were on the same committee together, that I admired him, but I didn't like him because he is just the type, like you four, that ruined the curve for guys like me.

But he has been a great benefit to this committee. He has been a benefit to me personally, and we are losing a great friend and a great Member of this conference, and we are going to call on you like we are Bart when he is an ambassador over in France or England, wherever he is. I want his telephone number, and I want yours.

I yield back.

Mr. EHLERS. Thank you very much.

Chairman GORDON. Thank you, Mr. Hall. Dr. Ehlers has been the conscience of the scientific community for us, and we thank you.

Mr. Wilson is recognized for five minutes.

Mr. WILSON. Thank you, Mr. Chairman, and gentlemen, I would like to echo the sentiments of Dr. Ehlers and others in saying that it is wonderful the work that you are doing and putting yourselves in a position to use the experience that you have acquired throughout your life, and your education, and your business experience, to help make our lives better and certainly for our next generation. So thank you. Thank you very much.

And I have a few questions I would like to ask, in no way provocative but just to try to get to the point of how we can maybe save some jobs for America and how we can do some of the things here.

My first is for Mr. Augustine. In your written testimony you mentioned that an American company, Applied Materials, recently opened the world's largest private solar research development company in China, and Dr. Barrett, also, my understanding that Intel has opened research labs on semiconductors and server networks in Beijing, China.

There are just two of the many instances of our U.S. jobs going overseas. What policies are necessary, from the government's standpoint, that we can use to incentivize companies to keep their jobs on American soil and employ American workers?

Mr. AUGUSTINE. Congressman Wilson, if I might answer that with a little story. I, in a moment of boredom, figured out that I have attended over 500 Fortune 100 board meetings, and in many of those we were faced with the kind of decision about which you ask. Should we build a plant in the United States, or should we build it overseas? If you build it in the United States, your average worker will come from the bottom quartile of the world's high school graduates. You will be in the country with the second highest tax rate, corporate tax rate, in the world. You will be in a country with a stagnating economy, or at best a stable economy. You will be in a country where you pay an assembly worker between four and 20 times what you would pay in many other countries. You will pay a chemist eight times as much and an engineer five times as much as in some highly qualified countries.

If you go to these other countries, you get, typically, a five-year tax holiday for the new facility you set up. Your average high school graduate employee will come from the top tenth of the [global] class. Engineers will be abundant. You will generally be given free land to build your plant. And if you are the strongest American in the world, acting as the fiduciary responsibility for your shareholders, you will build the plant overseas.

Now, that is what I have seen over and over, and those are the things we need to fix.

Mr. WILSON. Thank you.

Dr. BARRETT. Norm mentioned a number of features which—some of them are related to manufacturing, and some of them to R&D. I will just focus on the R&D side. The company I used to work for, Intel, is an international company, does about 80 percent of its business outside of the United States. That is, 80 percent of its revenue comes from foreign customers. To be internationally

competitive, the company has to hire the best and brightest engineers for its R&D laboratories wherever they reside.

If you look at where they reside today, some of them reside in the U.S., but some of them reside in Russia, some in China, some in Malaysia, some in India. We follow the best and brightest. Not all of the best and brightest are U.S. citizens. Therefore, to be competitive, we look around the world. As I said, 85 percent or so of our R&D activities are U.S. domestic located.

The things you can do would be to, in fact, follow the programs to get more U.S. kids interested in R&D or science, technology, engineering, and math, follow that through to get more of our young people majoring in those topics at the university level, have an immigration policy which allows foreign nationals who come to our universities and comprise the bulk of our STEM graduates to stay in the United States. Have a permanent R&D tax credit. Lower the corporate tax rate.

There are a whole litany of these items, but these are the things the government can do. You can't expect, I think, the multi-nationals to hire all U.S. citizens, because we do the great majority of our business outside of the U.S. We are relatively proud that we still have the great majority of our work going on in the U.S. to service our international customers, but we can't be digital, 100 percent U.S., 0 percent foreign nationals.

Mr. WILSON. Mr. Chairman, I realize I am out of time, but if I could just thank them. Thank you both because really you focused the issue and framed it, and that is what I have been looking for in this hearing this morning.

And so thank you. I have other questions, Mr. Chairman, but I realize my time is up. Thank you, gentlemen.

Chairman GORDON. Mr. McCaul is recognized for five minutes.

Mr. MCCAUL. Thank you, Mr. Chairman, and thank the witnesses for being here today. I—as the Chairman knows, I have been a strong advocate and supporter of the COMPETES Act. My district has a research and development arm at the University of Texas in Austin. The high tech, all the companies you mentioned are in some form or fashion in my district, and it is a federal investment that, while I am against a lot of the current spending in the Congress, I think this is one of those investments that we can't afford not to do. And the return on the investment, like with the NASA Program, has been extraordinary.

We talked about the *Gathering Storm*. I agree, Dr. Mote, that this is a national security issue as well, but I see a 'gathering storm' occurring right now in the Congress as the COMPETES Act stagnates in the Senate, the possibility that it may not pass, in combination with the tax cuts expiring. And then we have an extraordinarily large tax increase, and I know the R&D tax credit is huge, I know the penalizing companies that do business overseas, and I think we need to incentive through the tax code businesses to locate here and create jobs here in the United States. And I think that is something we can do.

But the storm I see, though, is a combination of these two events, COMPETES not passing and then the tax cuts expiring, and I just—that is really the reality right now that we are looking

at in the Congress, and I just wanted to get the panel to comment on those two events colliding at the same time.

Mr. HOLLIDAY. First, I agree that these are very important issues. One thing I would like you to possibly consider is in the way you give credits for companies to locate here. Think about it project by project, not as an across-the-board issue. And Dan's summary of the six countries that were doing a good job, China and Singapore came to the top, and let me assure you they will sit down with any major company in the U.S. and talk about a project you want to put there and what do you need to accomplish it.

Norm described some of those kind of concessions about land and trading and so forth. We have that on the state level here. We don't have it on the national level, and I would urge you to think about some kind of an objective where it could not be politically motivated, but in the interest of the country to allow companies to come forward and make that case.

Mr. MCCAUL. That is a good point. Yes, sir.

Dr. BARRETT. Briefly, I use the example of the net present value of one of our manufacturing facilities. It is like a Texas Instruments. When Texas Instruments did a lot of manufacturing in the U.S., it was a multi-billion-dollar facility, employed a couple of thousand people at extraordinarily high manufacturing salaries. The disincentive in the United States to locate those facilities is the corporate tax rate and the lack of any incentives at the national level. State by state can give some incentives, but those are second-tier incentives relative to the federal tax rate.

The biggest disincentive is—to locating those facilities, ongoing, is in fact—essentially the highest corporate tax rate in the world, in fact, drives people to make the logical financial investment to locate those facilities outside of the U.S. into a low or zero tax rate environment.

Mr. MCCAUL. If I could just—because the companies I talk to in my district, they want to stay here in the United States, but we are not providing the incentives, and bottom line it is about making a profit. You have a duty to your shareholders, and if we can't incentive them to stay here, they are not going to, although they want to. They are patriotic, but . . . Dr. Augustine.

Mr. AUGUSTINE. I just wanted to add to your comments that I can't think of a stronger signal that this Congress could send, in a negative fashion, than to not pass the *America COMPETES Act*. The members of the science and engineering community and the business community I suspect might conclude that it is "over." I realize those are strong words, but they are considered words.

Just as an example, the sort of framework, as Congressman Wilson said—America has always been the leading country in particle physics. This country has always had the most powerful accelerator in the world. Now, for the first time, the most powerful accelerator is in France and Switzerland. The physicists from around the world are moving to France and Switzerland. They are leaving America and going there because that is where the work is, that is where the excitement is, that is where the promise is.

And that is the challenge I think we face.

Mr. MCCAUL. Right, and that is compelling testimony, Mr. Chairman, to say if it doesn't pass, it is over, and I think that—I would

love to see nothing more than this passing out of the Senate and being really the legacy of the Chairman who has tried to advance this and advance the ball, and I hope that this will have some impact on deliberations in the Senate so we can move forward in this Congress.

Thank you.

Chairman GORDON. Thank you, Mr. McCaul. You know, I think a common denominator here is that Intel, Lockheed, whoever it might be, DuPont, if they are looking to relocate, it is not between Tennessee and Texas. It is between the United States and somewhere else, and that we have to recognize that.

Ms. Johnson, the patient Ms. Johnson is recognized for five minutes.

Ms. JOHNSON. Thank you very much, Mr. Chairman. I apologize for being a little late. I was in the Senate testifying. There are people in the Senate who are trying to move this legislation. I don't know how successful they will be.

Let me say one of my questions was just answered. I was going to ask Mr. Augustine about how the businesses would see it if we did not pass the bill, and you answered very appropriately.

I am really at a loss. I want to thank Dr. Ehlers for being on this committee and offering his leadership. For 18 years I have been talking about the same thing, and I don't know whether we are gaining any ground or not, and listening to and reading your testimony it seems to me that we are going backwards. I really wish I knew what else I could do. I was sitting here thinking that maybe we need to have a summit with many of our business leaders and many of our leaders here in Congress so they could come to understand what we are facing. I am really pretty frustrated with where we are and getting our K-12 education in order. We hear a lot of talk about it. I haven't seen much of an improvement. As well as our basic college. We have a lot of scholarships offered, and we are trying to do all the things that could lend itself to making these strides, but it does not seem that we are making them.

Just give me—if all of you could just give me an idea of how you think we could go about educating our leadership here in the right committees so that we can move a little faster. I think Members of this committee understand that, but I am not sure whether we have that understanding across the board where we need it in our leadership here.

Dr. BARRETT. If I might just touch on the issue of education for one minute, I think all of us have been leading advocates for improving K-12 education in the United States, and all the statistics, as you correctly point out—17 year olds' understanding of math and science has not budged in three or four decades. It is absolutely flat while the rest of the world has come up, and we have gone from number one to the bottom quartile of the OECD countries.

As much of a pessimist as I am, I actually do see a couple of optimistic things happening. One is, we now have 37 states signed up for common core curriculum K-12 subject matter by subject matter. Now, signing up for something and doing something as you well know are two different things, but getting 37 states to sign up for a common core curriculum is the first step.

There is also a consortium of states that are providing a state-driven internationally benchmark common assessment tool. That is, do away with the 50 different state assessments and have a common internationally benchmarked assessment tool for K-12 education.

I frankly think those two things plus the private sector getting involved in Change the Equation and some other areas give a sense of hope. The Race to the Top Program of Secretary Duncan has caused over 30 states to change their legislative rules and regulations about charter schools, pay for performance.

All of these things are building blocks. They have not changed the bottom line yet. The results—the kids that get out of school this year are probably going to have the same results as the kids that got out of school last year, but at least we are finally attacking the basic fundamental building blocks.

Mr. HOLLIDAY. If I could share an example, I served for five years on China's Development Board where a group of business leaders and academics came to three days in Beijing to share with the highest levels of government what we thought China should do differently. If you could make the mirror image of that in the U.S. and invite business leaders and academic leaders from these growing countries in the world to come here and share their experiences of what the U.S. could do differently, it might change things.

Ms. JOHNSON. Thank you.

Mr. AUGUSTINE. My footnote would be that if you could have more hearings in committees other than this one where there is a strong understanding, I think, of the issues—where you had business people come in and explain why they put their plants in other countries, and what it means to jobs, and the standard of living, and national security in this country—I suspect that the three companies that we worked for are probably employing around a half million people, somewhere close to that—and I think we just need to get more people to come in and speak with Members to make clear what the consequences are.

Ms. JOHNSON. Thank you very much. Does anybody else have—

Dr. MOTE. Well, I would just like to comment on this. I think firsthand experience is really necessary to really understand the depth of our problem, and I would say that if the leadership could actually get first-hand experience in China, for example, and really understand how it works and what the competitive level actually is, it would be stunning for them. And it would change their whole perspective on all the issues that would come subsequently.

I don't think this can be learned out of books and out of hearings. It is a sort of cultural issue, and Singapore—as China has basically taken Singapore's play book—basically, China has designed its plan for infrastructure development and for market competitiveness following Singapore's model, and it is really frightening to see. It is so effective.

Mr. HALL. Mr. Chairman.

Ms. JOHNSON. Thank you very much.

Mr. HALL. Mr. Chairman.

Chairman GORDON. Mr. Hall is recognized.

Mr. HALL. I really think at this point we ought to point out our problems of the past and our mistakes of the past. I may be the only one here that remembers the super collider. Eddie Bernice probably remembers it. I remember when we got to the crossroads there, I think they either needed—I am not very good on math, but I think they either needed \$600 million or \$6 million, and we offered them either \$2 million or \$200 million. I can't remember which it was. It doesn't make much difference now because that is no money today, and I hope nobody ever tells this President how much a gagillion is.

But we turned them down, and we lost that. We wound up with a giant hole from Waxahachie, Texas, halfway to Dallas, and we lost our chance to go ahead in the world of science.

And so we have a history of not being practical and not salvaging a great—I went to Cern with others here, maybe some here were with us there. I even talked a lot of those people into coming to the United States to work and to help us get the super collider kicked off, and it was hard to say goodbye to them when they left to go back there to their old jobs.

But that is something we can look back on, a grave mistake that was made, and it was made because we didn't have sense enough to do what you men are suggesting to us to do at that time.

I yield back.

Chairman GORDON. Thank you, Mr. Hall.

We try to follow regular order here, which means that a lot of the work in this committee falls upon the subcommittees and the subcommittee chairmen and ranking members have to put really an exceptional amount of time into that, and Mr. Inglis has been one of those excellent ranking members on one of the most active subcommittees that we have, and I thank you for that contribution and also recognize you for five minutes.

Mr. INGLIS. Thank you, Mr. Chairman, and I want to join you and Ranking Member Hall in thanking the panel for focusing on energy as an opportunity for us, and so let me ask you whether the challenge there is that we haven't yet unleashed the power of free enterprise to fix the problem. I agree that some of the things we can do in this committee are important, very important to provide some research and that sort of thing.

If we could combine that effort with a way to make money out of inventing and commercializing the new fuels, then we would have something going. But our challenge is that the incumbent fuels, particularly transportation fuels being petroleum and coal in the case of electricity, the negative externalities are not recognized, the government is failing in its function to force the recognition of those negative externalities, and as long as they get freebies, then how do you compete? If you have got this better technology, how do you compete?

Cap and trade has just died, so we can give it a death certificate now. So how about an alternative which is a revenant or neutral carbon tax? Basically reduce payroll taxes and then an equal amount, shift the tax to carbon dioxide. Start out at \$15 a ton, end up at \$100 a ton over a 30-year period. Make it a border adjustable tax, WTO [World Trade Organization] compliant so that if you would move it on export, you impose it on import.

And then watch the free enterprise system say, oh, you wanted an alternative to petroleum? We got it, and we can make it and deliver it to the customer at a price point that can beat petroleum. But until we do that, take that action, it seems to me we are never going to get—we are going to continue to do these research things, which are fabulous, but until you get the lift of the free enterprise system saying, by golly, I can make a buck doing that, I can deliver it to a desiring customer, a useful product. When you get that, things start happening. So that is my little commercial for a 15-page alternative to the 1,200 page monstrosity of cap and trade.

And it is something that I think that conservatives thinking straight and liberals thinking straight should come together and say, that works, because, you know, this idea I have just described, Al Gore and Art Laffer agree on it, and if Al Gore and Art Laffer can agree, can't we get the country to agree? What do you think? Can we get folks to say, yes, free enterprise is going to deliver. The companies that you all have so effectively led can deliver the solutions here. Right? I mean, is that correct?

Mr. HOLLIDAY. I agree totally if we could have certainty around the energy environment—and you have described one way, there are other ways—it would unleash creativity in this country we cannot imagine. And I think we are better positioned than even China and Singapore to take advantage of that, because we can respond quicker to a market force than they ever can.

One simple example is playing out today. We didn't talk about unconventional natural gas three or four years ago. Nobody understood what it meant. Then natural gas spiked and people had confidence the price was going to be higher, we started raising all new questions we hadn't before, and now there is an opportunity in energy that is going to be very amazing. Not the answer, but amazing.

So I agree with you totally. We have got to let the market system work, and you can play a role in that.

Mr. INGLIS. Anybody else want to take a shot at that? Unleashing the power of the free enterprise system to solve it.

Mr. AUGUSTINE. Well, I suspect all four of us are great believers in the free enterprise system, but the market, of course, is reacting to the incentives that it sees today. And the study that Chad chaired, that I had the privilege of serving on, pointed out that the pharmaceutical companies, I believe, spent something like 15 percent of their revenues on R&D, aerospace industries around 10, 11 percent. The energy companies, the traditional companies, it is 3/10ths of a percent. And that is the "correct" thing to do for their shareholders in the model that we've built today. And so we need a new model.

Mr. INGLIS. Thank you, Mr. Chairman. Appreciate the opportunity.

Chairman GORDON. Thank you, Mr. Inglis, and I think we can probably expect a different view on something from Mr. Rohrabacher, who is recognized for five minutes.

Mr. ROHRABACHER. Not Comrade Rohrabacher? Well, thank you very much. Yeah. I do have some different thoughts on this.

I would suggest that perhaps the fundamental problem that we have is that we don't have anyone watching out for the American

people. Hear a lot of suggestions, in fact, a lot of them are detached from what is good for the American people as a people and what—you know, I don't think that we should have as many foreigners coming here, getting those graduate student slots, and then asking them to stay here. I don't think that is a good idea. I think it is a good idea to have American students, even if they are just the B+ students instead of the A+ students from India and China, it is better to have them in those positions.

This whole idea of—well, you could follow that right on through. We have acquiesced—the United States has acquiesced to a policy of a one-way free trade policy with China for 30 years.

Now, let me ask the panel. When a solar panel company sets up manufacturing in China, is that not because they cannot sell their panels in China unless they are manufactured there? So we let them get away with policies like that rather than having say, look, you have access to our market, we have got to have access to yours. We are not watching out for the American people. Our people are going to lose.

We have permitted the wholesale theft of our intellectual property for the last 30 years, not only to China but elsewhere, and I don't hear anything about that. The pharmaceutical companies that we just heard mentioned, they spent billions of dollars of research money, and what happens? The Chinese steal it, they go over there, and they are selling knockoffs. So what do they do? They have to pass on that price to the American people. We end up having the American people paying more for their medicine in order to subsidize the Chinese people whose medicine is being paid for by us.

The Chairman or the Ranking Member mentioned the super collider. All right. We didn't pay for it. Has China put any money into the super collider? Have they, panel? They put money into the super collider research? No, because they want us to put our money in so that they can take the benefits. So they can get the benefit of the research. Who is watching out for the American people?

I mean, I am sorry. I hear, you know, what I am hearing today is not something that gets to the point of how this average Joe out there who is unemployed is going to find himself in a job, or at least a well-paying job. What I am hearing is, you know, for example, we have heard education, education, education. I have sat through probably five of these hearings, and each time we bring up the idea that one of the major problems in education is that we have unions that are basically protecting mediocre teachers, and we got unions that are protecting people who teach courses that are not essential, and they have to be paid the same amount of money as someone who teaches engineering and science. Well, of course we are not going to get any high-quality engineering and science teachers if they have to get paid the same people who teach—as teach basket weaving. Well, the bottom line is unless we are willing to address these things and watch out for the American people, the American people are going to suffer, and I think that this is what is happening right now, especially in terms of China.

By the way, these graduate students that we want to keep here, why do we want to have Chinese students swarming into these graduate positions, teaching them information that costs us billions

of dollars of research to do, so they can go back to China, and they can then utilize that information to out compete us? They realize they are our adversary. We don't realize they are our adversary, and we are treating them as if it is okay to give them the edge on the American people.

And I am sorry if I sound a little bit wild here today, because I always do, but the fact is I feel—but I feel strongly, I feel totally strongly about this. Unless we start protecting the intellectual property rights of our people, of our companies from China and elsewhere—they got the biggest cyber spy network in the world at play in China right now, trying to glean anything they can from us—until we start protecting our intellectual property rights from outright theft and spying and having an equal trade relationship, our people are going to continue to suffer, and I think that is the basis of the problem, Mr. Chairman.

So with that said, please, you got four seconds to comment on my comment.

Dr. BARRETT. The best thing you can do for the—watching out for the American people is give the next generation of the American workforce the best education in the world. That is the only way they are going to compete. There is not a person on this panel who is not a parent and a grandparent who has grandkids, who want to have the same opportunity they did, and that means we want the United States to succeed.

Let me just offer a slight rebuttal to your comment about who wants Chinese students here, the A+ students. We have got plenty of B+ students. It is an A+ world. If you want to compete internationally, you need A+ students. We hire the best students we can. I wish they were American students. The matter of the fact is we have failed at getting our younger generation proficient and interested in the subject matter which is going to be the basis for the 21st century economy. We have to do a better job at that, and the private sector is stepping up.

I was just at the NBC Education Summit in New York City yesterday, where this topic was addressed for two full days—government reps, private reps. This is the challenge we have, and it is a uniquely American challenge. We have to educate our children to be successful in the international marketplace. You cannot have a Microsoft, a Cisco, an Intel, a DuPont with just B+ players. You cannot. You need the best talent from around the world to have those companies successful in the international marketplace.

Mr. ROHRABACHER. Even if the trading rules are set up so that their trading rules favor the Chinese?

Dr. BARRETT. I am, and as I think everyone on this panel would all be, for fair and legal trade, balance trade back and forth, protection of intellectual property. All of us would be proponents of those comments that you made, but the basic challenge that you have for the United States is, in fact, having a workforce which can be internationally competitive and then setting the playing field level in the United States with international companies.

That leveling of the playing field is, let's be legal with intellectual property and trade policies, but at the same time let us also recognize what the government's responsibility is: to set the playing field level for companies to operate here, to invest here. Why

penalize U.S. companies to make investments in the United States? That is exactly what we are doing today.

Chairman GORDON. The gentleman's time has expired. As you can see, we are a committee of a big tent.

Mrs. Biggert is recognized, and will be our last questioner in that we are going to be having votes here very shortly.

Mrs. BIGGERT. Thank you, Mr. Chairman, and I am sorry that I missed all of your testimony. You are all my heroes. I think what you are doing to really bring us back where we are—we just have to have the education of our kids, and we have got to move forward so much in the science and research.

And Mr. Augustine and Mr. Holliday, I know you both served on the *Gathering Storm*, which I thought—and Dr. Barrett. I am sorry. This was such an important thing, I think, for science in this country, and for us moving forward in this committee. And I also—then the American Energy Innovation Council, and I had the opportunity to go to the dinner before the press announcement of that, and this was really, I think, such an important, you know, step forward, too, as well as the revised *Gathering Storm*, but you just have to keep it up, because we really have to move forward, and I think we have, you know, in Congress, as far as our colleagues and knowing how much the research and development is.

I just want—I wanted to ask you that, you know, we have got still a limited amount of money. We are certainly not doing so well right now where we—but, you know, the COMPETES Act to me was really important, that we move forward with that.

But the *Gathering Storm* report says that we should double the funding for basic research, and then the Energy Innovation Council report I believe says that we should spend an additional \$11 billion on energy, technology, development, demonstration, and commercialization. So I think now, in the economic times that we are in, it is really hard to do everything that we want to do, and so if you were in Congress and you had to prioritize, which—how would you start with these areas and which would go first, and which would you give your first dollars to, the early-stage benefit, basic research, or the late-stage development and commercialization activities?

Mr. Augustine.

Mr. AUGUSTINE. That is a terrific question that we have all thought about a lot, of course. And it is a little bit like asking, do I want to give up water, or food? I think that we just can't afford not to do these things, and I think we can afford to do them. And I say that, for example, if Americans spent more on legal tobacco during these five years—we could have done every—all of the 20 recommendations, every one of them from the *Gathering Storm* study, for what the Americans spent on legal tobacco during that period of time, and had \$60 billion a year left over.

So we can afford it. And I realize that is a little different from the Federal Government's budget, but I think the things that Congressman Hall said—he had a little bit of fun with my comment at another event that I am an aeronautical engineer, and during my career I worked on many airplanes that were overweight, and I pointed out that we never solved that problem by taking off an

engine. And what we are talking here about are the engines, and I think we just have to do these things.

Mr. HOLLIDAY. Just to add, totally supportive of what Norm said, but as we met with the American Energy Innovation Council, we basically asked ourselves the question, how would we fund this? And if it was inside our companies, we would go through and take the lowest priority things we are currently doing and shift those funds to this. We would not create more funds for it. We would make choices. All of our experiences at a time like this forces you to make choices. You shouldn't miss that opportunity.

Mrs. BIGGERT. I was just on the Floor speaking about You Cut, and that is where we, you know, doing away with some of these program that we—have been in existence for a long time, and as Ronald Reagan said, the closest thing to eternal life is a federal program.

So we really do need to reprioritize our—whatever we are doing, but—and then just going back to the STEM education things, how can we really ask, you know, the people really realize that they are being shortchanged on the education, and we really have to improve that. We hear, you know, like with the Japanese that they are studying all the time or the Chinese, and, you know, their focus is on that education. I don't think that we want to have our students have to go to school seven days a week and things, but we have to find a way that we can really ramp that up.

Anybody like to address that?

Dr. BARRETT. Well, the priority of items there is, first and foremost, to get certified math and science teachers in our public education system, K-12, and there are a number of programs which have been started in that direction, and I heartily endorse them and push them forward.

The private sector has recently gotten involved. We were discussing before you were here something called Change the Equation with 100 plus companies trying to get kids more excited about studying STEM topics rather than, oh, wanting to be a lawyer or a doctor, but to focus on math and engineering as well.

But first and foremost, if you don't have good teachers in our K-12 system, you are certainly not going to get children enthused about studying math and science if they don't respect and they don't learn from the teachers in the classroom, and the teacher is not going to do a good job if he is afraid the kids know more than they do.

Chairman GORDON. I am sorry to say, but the gentlelady's time has expired.

As I mentioned earlier, we follow regular order here which puts a lot of work on our subcommittees and those chairmen. The subcommittees put in a great deal of time. Dr. Baird, working with Mr. Inglis, they have been good partners in bringing us good legislation, and I recognize you here for the—for now the final word.

Mr. BAIRD. Well, I thank the Chairman and mostly wanted to just thank you all. I believe that the work you did and that the Chairman did and this committee did may be central to the future of this country, without any exaggeration at all. This is an institution that feeds on hyperbole, but I don't think it is hyperbole here. I actually think ARPA-E and the various things you have rec-

commended that we have enacted, thanks to this Chairman and this committee, are profound game changers, and somewhere in this country there are some scientists who are going to be successful at finding those solutions to our energy problems that wouldn't be there without them.

And we put, you know—when in doubt, throw a commission at a problem around here—but this is a commission that really did something, and I just want to thank you for your years of service to our country and for your service on this commission, and since I have the privilege of the last word, I would like to ask my colleagues to join me in thanking this fantastic Chairman we have of this committee, who not only wrote that bill but has stewarded this committee in a fair, bipartisan, wise, and constructive manner and made a profound difference not only on the Committee but on the House of Representatives and his state and his country. And it has been a privilege to serve, and I would like people to join me in thanking Chairman Bart Gordon for his service.

Chairman GORDON. Thank you, Dr. Baird. I wish that I could yield more time to you, but time is coming to a close. Before we bring the hearing to a close I want to sincerely thank our witnesses, not just for being here today but for your continuing commitment to these issues that we are all very committed to also.

The record will remain open for two weeks for additional statements from the Members and for answers to any follow-up questions the Committee may ask of the witnesses.

Now I would like to turn the gavel over to Mr. Hall.

Mr. BAIRD. That is a bit premature, Mr. Chairman.

Mr. HALL. Now I would like to yield myself one hour. I join in thanking you, and I thank this fine Chairman here. I hope I am the Chairman almost a year from now, but I couldn't ask for a better Chairman than you have been, Republican, Democrat, or third party. He has been totally, completely fair, and I never knew a person from Tennessee that I didn't admire because but for Tennessee it wouldn't be a Texas, and Bart always says, well, there wouldn't have been a Texas anyway if there was a backdoor in the Alamo.

So—but these men and women that are leaving us, I appreciate them. Dr. Baird, we will really miss you and your knowledge and background and genuine interest in what Jeremy Bentham called “the greatest good for the greatest number.” We appreciate all of you.

With that do I hear a motion to adjourn.

VOICE. Motion to adjourn.

Mr. HALL. We are adjourned.

[Whereupon, at 11:54 a.m., the Committee was adjourned.]

Appendix:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Norman R. Augustine, Retired Chairman and CEO of the Lockheed Martin Corporation and Former Undersecretary of the Army

Questions submitted by Chairman Bart Gordon

Q1. I began my questions by asking you and the other witnesses to comment on the appropriate public and private sector roles in fostering innovation. In response, the witnesses appeared to agree that the federal government should sponsor activities primarily in the area of basic research. However there was not a clear consensus among the witnesses on what “basic research” might include, and therefore, what the appropriate government role should be in supporting a wide array of innovation mechanisms.

I also asked why energy warrants a particular focus. The recent report by the American Energy Innovation Council (AEIC), which includes Mr. Augustine and Mr. Holliday, called for federal investment in clean energy innovation (including research and development through finance and deployment) to more than triple to \$16 billion annually. Mr. Holliday asserted that such an investment in energy innovation could transform the entire economy, strengthen our national security, and reinvigorate the manufacturing sector along with the overall productive capacity of the country.

Using ARPA-E as an example, to date this new agency has selected a total of 121 projects based in 30 states, with approximately 39% of projects led by universities, 33% by small businesses, and 20% by large businesses. Almost all projects also have multiple partners. Both the Gathering Storm report and the AEIC report strongly recommend additional funding for ARPA-E to build on its progress to date. Given the shifting landscape of global competitiveness, is it appropriate and important for innovative programs, such as ARPA-E, to support a wide range of activities, including by continuing to leverage nascent private sector efforts and investment in emerging technologies?

A1. It is my belief, having spent nearly a third of my career in government and most of the remainder in the private sector, that government in a free enterprise system should do only those things that cannot be done well by the private sector. As it happens, there are a number of examples of such circumstances, including undertakings the results of which are beneficial to society as a whole but may not return commensurate benefits to the pursuers of those undertakings.

Basic research is one such example. I would define basic research as the effort to understand the fundamentals of nature; that is, curiosity-driven scientific exploration. Basic research entails substantial risk, produces often unexpected benefits, frequently takes a long time to convert into financially rewarding products and services, and often rewards individuals or organizations other than the investors or performers themselves. This seems to be an example of the category of effort that government should fund . . . but not necessarily perform.

The need for government support of innovation goes well beyond the funding of basic research itself. In addition to creating an innovation-friendly environment (tax policy, intellectual property protection, education . . .), there are hurdles in the knowledge-to-the-marketplace progression wherein government assistance is also needed if they are to be overcome. I like to think of this spectrum of activities as including at least two segments . . . sometimes referred to as the “Valleys of Death” . . . that are particularly unattractive from the standpoint of commercial investors.

The first of these Valleys often follows the discovery of new phenomena offering promising applications. Unfortunately, it is not uncommon in this circumstance that there remains significant risk and uncertainty that deters individual and corporate investors—even though, if successful, the product sought would be of substantial benefit to society as a whole or at least some large segment of society.

The second Valley occurs after a prototype has been built that seems to confirm the underlying feasibility of the product being sought but does not provide convincing evidence that the prototype can be “scaled-up” to a degree useful for commercial application. In some cases these barriers are not unduly high—in which case no government involvement is needed. But, in other cases, particularly in the field of energy-provision, this step can represent investments of hundreds of millions of dollars—and take many years. This is thus the sort of activity that I believe it is appropriate for the government to underwrite.

ARPA-E is intended to aid in transiting the first of these Valleys—and one of the recommendations offered by the American Energy Innovation Council was intended to address the second.

Based on my own experience it is very appropriate for organizations such as ARPA-E to take ideas and new knowledge that may have been generated in the private sector or our research universities and nurture them to the point that the private sector can, while also carrying out its fiduciary responsibilities to its investors, pursue them until they become marketable or at least potentially capable of scalability. In doing this, it is important that to the degree possible the government seek to assure that no individual firm receives advantage beyond that which may result from investments the firm itself may have made or competitively accrued.

Questions submitted by Representative Ben R. Luján

Q1. The original report called for an expanded role for national laboratories, that they can help fill the gap left behind now that corporations have moved away from long term R&D and they can transition new discoveries to commercially viable technologies. I believe the national labs are a great resource, not only for fundamental science and national security, but also for spurring innovation through partnerships with businesses. I'd like to get your impression on promoting the ability of national lab scientists and engineers to provide technical assistance to small businesses. As an example, there is a program in New Mexico, the New Mexico Small Business Assistance Program, in which the state pays for personnel at either Los Alamos or Sandia national labs to spend a small amount of time to assist New Mexico businesses on some of their technical problems. It has become very popular and I think proves the value of the skilled personnel at national labs, not just the technology or user facilities, for helping businesses to be more competitive and innovative. So I'd like to hear of your opinion on this issue, on promoting ways for businesses to make use of the technical expertise at the national laboratories.

A1. I believe that national laboratories play an important role in the innovation cycle . . . but that one of their roles is to support industry, not to compete with it. The dilemma faced, of course, is that in pursuing the work of the laboratories it is important that, to the extent possible, they not favor any particular firm. Yet it is essential that the laboratories work cooperatively with the private sector since it is only the latter that can reasonably be expected to take products into the marketplace and create jobs . . . at least this is the case in the free enterprise system upon which this nation is in part built.

These considerations and others lead me to believe that the national laboratories should focus on the creation of new knowledge through basic research and assist industry in translating that knowledge into products and service for the marketplace. This necessitates a close working relationship between industry and the government laboratories. It also indicates that the work pursued by the national laboratories should offer major breakthroughs—an outcome often accompanied by significant risks, high costs and long-term endeavors—not just marginal improvements. The use of nuclear fusion as an energy source would be an extreme example of such a circumstance. Successful nuclear fusion could, in my opinion, be of extraordinary importance to our citizenry—but it is extraordinarily expensive, still entails significant technical risk in terms of viability, is extremely costly to carry to the application phase, and is still distant in time.

In summary, I believe there is an important role for the laboratories to support our nation through promoting ways by which businesses can apply the results of the laboratories' work.

Q2. Your written testimony states that six million more American youth have dropped out of high school since the original Gathering Storm report was produced. I believe this highlights a very serious problem facing America's youth and the future of our workforce. My home state of New Mexico suffers from public school graduation rates that are consistently below 70 percent. As you know, this is particularly alarming because these students will be cut off from opportunities to obtain a college education and become part of the robust high-tech workforce America so desperately needs.

Can you discuss how Congress can make the necessary investments in K-12 STEM education, tutoring or mentoring programs to combat dropout rates and ensure that our students are successfully graduating from high school?

A2. Thank you for that question. I might begin by noting that the high school “dropout” rate you cite for New Mexico, while altogether unacceptable, is only slightly below that of the nation as a whole. The problem you describe is, based on the various studies in which I have participated, the most important single challenge currently facing our country. As you know, education in America is principally the

province of states and localities . . . resulting in some 14,000 independent school districts bearing responsibility for educating our children.

But there is much that Congress can, and in my opinion should, do to facilitate better educating our nation's young people. One of these is to offer competitive scholarships for U.S. high school graduates to attend U.S. universities and pursue degrees in engineering, math or science while simultaneously receiving training in pedagogy. In return, the recipients would agree to teach in our nation's public schools for a prescribed period of years.

It is also important that we create opportunities in the early grades, and even before students enter the public school system, to prepare them for the academic rigors they will soon face. This could be done through funding of pre-school and after-school programs, and the use of technology for learning at home.

The matter of assuring that students graduate from high school can be assisted by providing formal mentoring and financial aid to students who may be otherwise be highly qualified but are obliged to withdraw from school for family financial reasons.

Further, we should create a system of rewards for extraordinary teachers: we should pay physics teachers more than phys-ed teachers and we should pay good physics teachers more than poor physics teachers—and we should not tolerate inept physics teachers. The teaching profession should be revered, given its importance to our nation's future. We should have standards for our students to meet and we should test against those standards. We should take special steps to assist economically deprived young people.

Given that the black and Hispanic communities are badly under-represented among graduates from, for example, engineering schools, and the fact that these communities are the fastest growing segments of our nation's population, portend a worsening competitiveness picture unless we take decisive action. If we remain on the current path, in just 15 years the U.S. will be in last place among all the world's industrialized nations in terms of the fraction of our graduates receiving degrees in engineering. Given the importance of engineering to growth in the Gross Domestic Product and the creation of jobs, this is not a formula for an attractive quality of life for either our children or our grandchildren.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Craig Barrett, Retired Chairman and CEO of Intel Corporation

Questions submitted by Chairman Bart Gordon

Q1. I began my questions by asking you and the other witnesses to comment on the appropriate public and private sector roles in fostering innovation. In response, the witnesses appeared to agree that the federal government should sponsor activities primarily in the area of basic research. However there was not a clear consensus among the witnesses on what “basic research” might include, and therefore, what the appropriate government role should be in supporting a wide array of innovation mechanisms.

I also asked why energy warrants a particular focus. The recent report by the American Energy Innovation Council (AEIC), which includes Mr. Augustine and Mr. Holliday, called for federal investment in clean energy innovation (including research and development through finance and deployment) to more than triple to \$16 billion annually. Mr. Holliday asserted that such an investment in energy innovation could transform the entire economy, strengthen our national security, and reinvigorate the manufacturing sector along with the overall productive capacity of the country.

Using ARPA-E as an example, to date this new agency has selected a total of 121 projects based in 30 states, with approximately 39% of projects led by universities, 33% by small businesses, and 20% by large businesses. Almost all projects also have multiple partners. Both the Gathering Storm report and the AEIC report strongly recommend additional funding for ARPA-E to build on its progress to date. Given the shifting landscape of global competitiveness, is it appropriate and important for innovative programs, such as ARPA-E, to support a wide range of activities, including by continuing to leverage nascent private sector efforts and investment in emerging technologies?

A1. I believe the role of government financing of research should be primarily limited to basic research—that is research in the pre-competitive phase, many years from commercialization. This is the sort of research that would be carried out in tier 1 research universities with occasional partnership with industry. I am not in favor of massive investment by the government designed to commercialize research topics—when someone speaks of a \$16B investment it strikes me that this is asking the government to pick between winners and losers rather than in developing the next generation of technology. So I am in favor of expanding on the good work done by the NSF and equivalent agencies (doubling the NSF budget would be my goal) but I would not favor the massive investment of government funds to commercialize technology. Re: the issue of ‘why energy research’, I believe the answer is mere the pragmatic realization that alternative energy is the Sputnik of the 21st Century. The need is obvious, everyone can associate with the bottom line result, the geopolitical issues are profound, and the opportunity for world leadership is apparent.

Questions submitted by Representative Ben R. Luján

Q1. I am encouraged by the great strides Intel and other large tech companies have taken to partner with educators to support STEM education programs. In New Mexico, our local Intel has been a committed partner in recent STEM initiatives that are designed to give students hands-on experience with real-world technology projects.

a. As public-private STEM partnerships continue to grow, how can we ensure that corporate investments in STEM are benefitting our neediest students, especially low-income and minority students? These students are too often underrepresented in science and technology fields, and we must make sure that they are included in emerging high-tech industries.

b. My district in NM is largely rural. Oftentimes rural classrooms face teacher shortages, or are not equipped with the most up-to-date computer equipment or access to broadband. Can you comment on how we can utilize public-private partnerships to overcome challenges associated with STEM education in rural communities?

A1. I believe the current private effort “Change the Equation” provides the appropriate response to both the issue of minority involvement in STEM and the association of the private sector with economically depressed regions. This effort of over 110 companies has within its charter working with minorities and having companies

work in their local environments to help bring technology to all regions of the US. The issue of New Mexico and Intel is a perfect example of how such a partnership can work. The fact that 110 companies have committed to this effort is an indication that they are serious in following up on this important issue.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Charles Holliday, Jr., Chairman of the Board of Bank of America and Retired Chairman of the Board and CEO of DuPont

Questions submitted by Chairman Bart Gordon

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A1. It is of the utmost importance for the U.S. to support highly innovative, highly subscribed, and high potential programs like ARPA-E that are fostering game-changing energy technology developments and will help the U.S. become a technologic leader in clean energy technologies in the 21st century. Both the Gathering Storm report and the American Energy Innovation Council recommendations make it quite clear that ARPA-E represents a successful model framework that will enable the nation's best innovators to pursue truly novel ideas. Supporting ARPA-E—and other institutional frameworks like it—should be a national priority.

Innovative programs such as ARPA-E are critically important precisely because they focus on high-risk, high-payoff emerging technologies. ARPA-E, for example, does not fund discovery science, nor does it support incremental improvements to current technologies. Rather, projects are selected and supported because they represent the potential to fundamentally shift technology in a different direction. By definition, then, these technologies are highly risky, which largely means that private sector firms can't or won't support them alone. This is where the role of ARPA-E is pivotal: the agency solicits innovative proposals from companies, laboratories, and universities and supports the best ideas through early product development and testing to the point when private sector players are willing come in and make additional investments to scale up and broadly commercialize successful technologies. By supporting a diverse portfolio of the most innovative proposals in clean energy, public investments made by ARPA-E will ultimately leverage private sector investments many times over. Only ideas that have strong potential to make rapid progress toward market commercialization are supported, and funds are not extended without demonstrable progress within two or three years. In short, there is no other government agency or private sector entity that can support the early stage development of such a wide range of promising energy technologies.

As my AEIC colleagues and I noted in our report, A Business Plan for America's Energy Future, ARPA-E has high potential for long-term success, but only if it is given the autonomy and budget to support the game changing technologies the U.S., and the world, critically needs. In our global, ultra-competitive world, programs such as ARPA-E that enable U.S. businesses to pursue the most innovative technologies conceived are not just important; they are essential if the U.S. is to maintain its place as home to the world's leading innovators.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. C.D. (Dan) Mote, Jr., President Emeritus of the University of Maryland and Glenn L. Martin Institute Professor of Engineering

Questions submitted by Chairman Bart Gordon

Q1. I began my questions by asking you and the other witnesses to comment on the appropriate public and private sector roles in fostering innovation.

A1. Regarding fostering innovation, a complete innovation system has both a top-down (government driven) and a bottom-up (private sector drive) component. No fully complete innovation system currently exists in the world. Singapore and China have relatively strong top-down components and are working to build their bottom-up components to become the first complete system in the world. They have a way to go to be certain, but they know where they are going and are on the road. The U.S. has yet to recognize that a top-down component is necessary.

The current U.S. government role is to be indirectly supportive of private sector developments by supporting pre-competitive, openly available, basic research functions at national laboratories and research universities. As important to U.S. competitiveness, universities simultaneously prepare/educate the pipeline of the future research leadership for industry, government and universities. Basic, pre-competitive, publicly available research contributions no longer come from industry. Industry develops proprietary products, which are not basic research and no federal support is sought for these purposes. Either government laboratories or universities undertake basic research for the United States, or it is not done in this country at any large scale. If the centers of basic research move elsewhere in the world, U.S. dominance in science and engineering, a national hallmark for half a century, will move with it.

Federal government support for research facilities is a critically important part of government support for modern research. Support for facilities in universities is not available through research grants, and States and industry do not support facilities. It is Catch 22. Without adequate facilities, universities cannot compete for grants to undertake research and train/educate students. Without the grants for research, funds to build facilities are not available because of competing needs.

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What is Basic Research here? Basic research is the systematic study of fundamental questions in physical, engineering, mathematical, computer, and life sciences that can lead to greater knowledge or understanding and to potentially broad and/or path-breaking applications in the future. History verifies that far-sighted, high-payoff research has provided the bases for the technological progress that has built this nation. Basic research may lead to applied research for development of commercial products, security-center technologies and other technologies, to development of new functional capabilities, or to the discovery of additional new knowledge with its concomitant values thereby renewing the process.

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A sufficient supply of clean and affordable energy is a ubiquitous security and prosperity problem for the nation. The problem can only worsen without the development of new technologies relying on basic research. Because “the energy problem” spans all national interests, it is an important one to address. ARPA-E, modeled after the Defense Advance Research Projects Agency, is an element of a top-down innovation environment, and an important one for that reason as well as for its contributions to the energy problem. The decade old In-Q-Tel is another top-down entity. So other targeted, top-down innovation centers can also be effective if structured like ARPA-E.

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