

# Green Technology Innovation in the United States: The Obama Administration's Ambitious Program and its Prospects

Albert H. Teich\*

## ABSTRACT

The American Recovery and Reinvestment Act (ARRA), known widely as the “stimulus” bill, developed by the U.S. Congress and President-elect Obama in late 2008 and early 2009, is investing a significant portion of its \$787 billion infusion of funds in future-oriented programs intended not only to “jump-start” the stalled American economy, but to promote the development of renewable energy sources and increase energy efficiency in appliances, buildings, transportation, and other sectors of the economy. These investments are expected both to create immediate employment in green industries and to build a more sustainable society in the long term.

The Obama Administration's green energy initiatives are part of a larger emphasis on science and technology within its agenda. It has roots in the Obama campaign and is supported by an unusually strong science and technology team. Much of the activity is centered in the Department of Energy, which received a huge one-time increase in its fiscal year 2009 budget to support the new and expanded programs. Areas that have been neglected by the federal government R&D program for many years, including smart grid technology, solar, wind, and geothermal energy, received large boosts. Many of these programs – and, in fact, the broader concept of government involvement in commercial innovation – are politically controversial. Previous attempts to expand research in these areas by liberal Democratic administrations and Congresses have been criticized and sometimes thwarted by conservatives. Whether President Obama's efforts will meet with more success, both politically and technologically, remains to be seen.

**KEYWORDS:** stimulus, innovation, energy, sustainable, transformative

## 1. INTRODUCTION

In the weeks between his election victory on November 8, 2008 and his inauguration on January 20, 2009, President-elect Barack Obama, working with Democrats in Congress, saw a unique opportunity to promote innovation in environmentally-friendly, sustainable “green” technology—a key interest of his and his congressional allies—by making it part of the huge emergency economic stimulus that most policymakers agreed was needed to keep the U.S. economy from falling deeper into recession. In an unprecedented action, a total of \$787 billion was appropriated by Congress in February 2009 as a supplement to the regular fiscal year 2009 federal budget—despite the fact that the budget itself had not yet received final passage.

The stimulus was intended to use government spending to create jobs and give the economy an urgently-needed boost. Much of the money was allocated to programs expected to have an immediate impact on the economy and to help those most in need: aid for low income communities with large job losses, tax cuts for low and middle-income families, construction jobs, and the like. However, instead of directing all of the spending at short-term needs, the stimulus bill, known formally as the American Recovery and Reinvestment Act (ARRA) is investing a significant portion of this massive infusion of funds (up to \$86 billion, depending upon how one counts) in future-oriented programs intended not only to create jobs and “jump-start” the economy, but to promote the development of renewable energy sources, and increase energy efficiency in appliances, buildings, and other sectors of the economy. Additional funds are being invested in research and development in health and biomedical science, basic physical sciences, nanotechnology, and other fields, as well as in education. Together, these investments are expected both to create immediate employment in green industries and to build a more sustainable society in the long term.

Skeptics abound—of the stimulus as a whole, and of its focus on green innovation. How well it will work depends on many factors and will only be known as the future unfolds. This paper describes the Obama Administration’s program of green innovation and seeks to understand it in the context of the politics of innovation and of alternative energy in the United States.

## 2. GREEN PROMISES

The Obama Administration’s program for green technology innovation has several elements. Key to the plan is using the stimulus to accelerate development and adoption of renewable energy technologies and innovation, while simultaneously creating jobs to bolster the sagging U.S. economy. The plan calls for promoting the use of current and near-term technologies to make incremental improvements in energy use, supporting “transformative” R&D in the hopes of finding breakthrough technologies, and creating demand for more efficient technologies with regulation using the “cap-and-trade” approach.

Barack Obama laid the foundation for his administration’s program of green innovation during the Presidential election campaign of 2008. He outlined his plans in speeches and interviews, but the

---

\*Director, Science and Policy Programs, American Association for the Advancement of Science (AAAS)

answers he provided to the questions posed by the organizers of Science Debate 2008 effectively set the stage for the initiatives he has undertaken in his presidency. Science Debate 2008 is a nonprofit organization “dedicated to elevating science and engineering policy issues in the national dialogue.”<sup>1</sup> Established during the campaign, it sought to achieve its goals by organizing and hosting debates on science and technology policy between candidates for office, notably the major party presidential candidates. The emergence of Science Debate 2008 was a symptom of the discontent many in the scientific community felt after eight years of the presidency of George W. Bush. More importantly, its organizers saw it as a vehicle for improving the prospects of science and technology in the next administration.

Although Science Debate 2008 failed to achieve its stated goal of bringing Barack Obama and John McCain together in a debate devoted to science and technology policy, it did succeed in focusing attention on a number of key S&T policy issues, including innovation, climate change, energy, and environmental sustainability. It did this, in part, by obtaining detailed responses from both candidates to a set of 14 questions that were a selection and synthesis of more than 3,400 submitted by scientific organizations and individuals across the country. These questions focused on some of the “largest and most important unresolved challenges currently facing the United States.”<sup>2</sup>

Candidate Obama’s responses to several of these questions provide a blueprint of his thinking on green technology innovation:

**Q: *What policies will you support to ensure that America remains the world leader in innovation?***

*A: My administration will increase funding for basic research in physical and life sciences, mathematics, and engineering at a rate that would double basic research budgets over the next decade. We will increase research grants for early-career researchers to keep young scientists entering these fields. We will increase support for high-risk, high-payoff research portfolios at our science agencies. And we will invest in the breakthrough research we need to meet our energy challenges and to transform our defense programs.*

**Q: *What is your position on the following measures that have been proposed to address global climate change—a cap-and-trade system, a carbon tax, increased fuel-economy standards, or research? Are there other policies you would support?***

*A: . . . We must also take a leadership role in designing technologies that allow us to enjoy a growing, prosperous economy while reducing greenhouse gas emissions by 80 percent below 1990 levels by 2050. . . I will implement a market-based cap-and-trade system to reduce carbon emissions by the amount scientists say is necessary. . . I will restore U.S. leadership in strategies for combating climate change and work closely with the international community. We will re-engage with the U.N. Framework Convention on Climate Change, the main international forum dedicated to addressing the climate change problem.*

**Q: *What policies would you support to meet demand for energy while ensuring an economically and environmentally sustainable future?***

*A: I have proposed programs that, taken together, will increase federal investment in clean energy research, development, and deployment by \$150 billion over ten years. This research will cover:*

---

<sup>1</sup> Science Debate 2008 home page. <http://www.sciencedebate2008.com>.

<sup>2</sup> Ibid

- Basic research to develop alternative fuels and chemicals;
- Equipment and designs that can greatly reduce energy use in residential and commercial buildings – both new and existing;
- New vehicle technologies capable of significantly reducing our oil consumption;
- Advanced energy storage and transmission that would greatly help the economics of new electric-generating technologies and plug-in hybrids;
- Technologies for capturing and sequestering greenhouse gases produced by coal plants; and
- A new generation of nuclear electric technologies that address cost, safety, waste disposal, and proliferation risks.<sup>3</sup>

Of course, campaign promises in any democratic political system are, in reality, wish lists. It is much easier for a presidential candidate to list all the good things he or she intends to do than it is for a President to actually do them. Filling the gap between words and actions requires money, political capital, and a team capable of carrying out the candidate's lofty plans. The President's agenda must have the support of the electorate and he must be capable of getting the legislative branch to enact it. Although innovation policy, climate change, and energy were important elements of the Obama campaign, the polls suggested that they were pretty far down on the list of voters' concerns and among the factors that contributed to Obama's victory—well below the economy, the war in Iraq, health care, and terrorism.<sup>4</sup> In ordinary years, the green technology proposals and plans would have had to take their place in line behind these more salient issues. But 2008 and 2009 were not ordinary years.

### 3. THE ECONOMIC MELTDOWN: CRISIS AND OPPORTUNITY

In the weeks before and immediately following the election, one did not need to consult the polls to know that the economy was the major concern of the American people. Economic growth had drifted into negative territory, indicating that the economy was sliding into recession. Employment was declining rapidly as businesses began to shrink or close, and nationwide unemployment skyrocketed from around five percent in the early part of 2008 to over eight percent by February of 2009.<sup>5</sup> Congressional leaders were acutely aware of this, and worked feverishly in collaboration with the Obama transition team to craft an emergency bill intended to give the U.S. economy a sharp boost. The central aims of the “stimulus,” as it quickly became known, were to provide immediate relief for people who were in need of financial help, to create jobs for those who were unemployed, and to start the economy growing again. It was widely recognized among policymakers that it was going to be expensive and that it would have to be financed by increasing the deficit. While that fact generated some political angst and opposition, in a sense, it also freed the drafters of the bill from many of the constraints of normal government spending. In order to have the desired impact, it would need to

---

<sup>3</sup> <http://www.sciencedebate2008.com/www/index.php?id=42>.

<sup>4</sup> CNNPolitics.com Election Center, Issue Tracker. <http://www.cnn.com/ELECTION/2008/issues/>.

<sup>5</sup> U. S. Department of Labor, Bureau of Labor Statistics, “Labor Force Statistics from the Current Population Survey,” January 3, 2010. [http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series\\_id=LNS14000000](http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=LNS14000000).

be massive and implemented on an unprecedentedly rapid timetable. These requirements opened a range of possibilities beyond the scope of ordinary legislation. Ideas that might have taken months or even years to implement during normal times were suddenly within immediate reach. Among these were many items from President Obama's green technology wish list.

The final bill, officially titled the "American Recovery and Reinvestment Act of 2009" (Public Law 111-5), but better known as "ARRA" or "the Recovery Act," received final passage by the House and Senate on February 13, 2009 and was signed by President Obama on February 17, less than one month after his inauguration. Technically, ARRA is a supplement to the regular fiscal year (FY) 2009 appropriations for the federal government, even though the regular appropriations process had not yet been completed by the time ARRA was signed into law. The cost of the bill, including both direct appropriations and tax cuts, was \$787 billion, or more than a quarter of the entire \$2.9 trillion federal budget for the previous year. The largest share of money was allocated to tax relief for individuals and companies as well as to aid low income workers, the unemployed, and people on fixed incomes (i.e., retirees). However, the amount allocated to longer-term goals, including green technology, was far from trivial. As the title of the Act states, it is intended to promote both recovery and reinvestment.

### Section 3 of the Act ("Purposes and Principles") states its goals:

1. To preserve and create jobs and promote economic recovery.
2. To assist those most impacted by the recession.
3. To provide investments needed to increase economic efficiency by spurring technological advances in science and health.
4. To invest in transportation, environmental protection, and other infrastructure that will provide long-term economic benefits.
5. To stabilize State and local government budgets, in order to minimize and avoid reductions in essential services and counterproductive state and local tax increases."<sup>6</sup>

Although these goals do not specifically mention green technology, the concept is clearly implied in the notion of "increase[ing] economic efficiency by spurring technological advances" and investing in "environmental protection and other infrastructure that will provide long-term economic benefits." Many of Obama's specific ideas for promoting green technology innovation are apparent in the act's detailed provisions. To be sure that the message was received, however, the President underlined them by traveling to Denver, Colorado, and holding the signing ceremony at the Denver Museum of Nature and Science after touring the solar photovoltaic energy installation on the museum's roof.

---

<sup>6</sup> H.R. 1, "The American Recovery and Reinvestment Act of 2009," [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111\\_cong\\_bills&docid=f:h1enr.pdf](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h1enr.pdf).

<sup>7</sup> CNN.com, "Obama's Remarks on Signing the Stimulus Plan," February 17, 2009. <http://www.cnn.com/2009/POLITICS/02/17/obama.stimulus.remarks/>.

<sup>8</sup> President Barack Obama's Inaugural Address, January 21, 2009. <http://www.whitehouse.gov/blog/inaugural-address/>

<sup>9</sup> Climate Science Watch. "Climate change and sustainable energy in President Obama's proposed FY 2010 budget." [http://www.climateciencewatch.org/index.php/csw/details/obama\\_fy2010\\_budget\\_climate\\_energy/](http://www.climateciencewatch.org/index.php/csw/details/obama_fy2010_budget_climate_energy/).

In his speech at that ceremony, President Obama highlighted his belief that the kind of jobs the bill was creating will lead not just to short-term economic benefits, but to a better future:

What makes this recovery plan so important is not just that it will create or save 3½ million jobs over the next two years . . . . It's that we are putting Americans to work doing the work that America needs done in critical areas that have been neglected for too long, work that will bring real and lasting change for generations to come. . . .

Because we know we can't power America's future on energy that's controlled by foreign dictators, we are taking a big step down the road to energy independence and laying the groundwork for a new green energy economy that can create countless well-paying jobs. It's an investment that will double the amount of renewable energy produced over the next three years and provide tax credits and loan guarantees to companies like Namaste Solar [the firm that provided the museum's solar electric installation], a company that will be expanding, instead of laying people off, as a result of the plan I am signing.<sup>7</sup>

#### 4. SCIENCE IN THE OBAMA ADMINISTRATION

Obama's green technology plans are part of a much broader interest in science and technology. To an extent far exceeding that of any of his recent predecessors Obama has integrated science and technology into his administration and he has made it one of his priorities. Responding to the widespread belief that science had been neglected and subordinated to ideology during the administration of George W. Bush, he pledged during his inaugural address to "restore science to its rightful place."<sup>8</sup> As noted above, he chose to sign the Recovery Act at a science museum. Shortly afterwards, he released his climate change plan, calling for a broad range of investments in clean energy, including a substantial amount of R&D, as part of an outline of his fiscal year 2010 budget.<sup>9</sup> In early March, he issued an executive order reversing the Bush Administration's ban on federal funding for human embryonic stem cell research, as well as a presidential memorandum directing federal agencies to insure the integrity of science in their actions.<sup>10</sup> In late April he addressed the members of the U.S. National Academy of Sciences during their annual meeting in Washington, highlighting his commitment to scientific research and education and setting a goal of 3 percent of GDP for U.S. investment in research and development.<sup>11</sup> In a speech at a community college in an economically depressed area of upstate New York in late September, he presented his plan for enhancing innovation in the U.S.<sup>12</sup> And a month

---

<sup>10</sup> The White House, "Executive Order: Removing Barriers To Responsible Scientific Research Involving Human Stem Cells," March 9, 2009. [http://www.whitehouse.gov/the\\_press\\_office/Removing-Barriers-to-Responsible-Scientific-Research-Involving-Human-Stem-cells/](http://www.whitehouse.gov/the_press_office/Removing-Barriers-to-Responsible-Scientific-Research-Involving-Human-Stem-cells/) and "Memorandum For The Heads Of Executive Departments And Agencies on Scientific Integrity," March 8, 2009. [http://www.whitehouse.gov/the\\_press\\_office/Memorandum-for-the-Heads-of-Executive-Departments-and-Agencies-3-9-09/](http://www.whitehouse.gov/the_press_office/Memorandum-for-the-Heads-of-Executive-Departments-and-Agencies-3-9-09/).

<sup>11</sup> The White House, Remarks of President Barack Obama at the National Academy of Sciences, April 27, 2009. <http://blogs.sciencemag.org/scienceinsider/2009/04/obama-at-the-ac-2.htm>.

<sup>12</sup> The White House, "Remarks By The President On Innovation And Sustainable Growth," Hudson Valley Community College, Troy, New York, September 21, 2009. [http://www.whitehouse.gov/the\\_press\\_office/Remarks-by-the-President-on-Innovation-and-Sustainable-Growth-at-Hudson-Valley-Community-College/](http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-on-Innovation-and-Sustainable-Growth-at-Hudson-Valley-Community-College/).

later, he went to the Massachusetts Institute of Technology, where students and faculty are deeply involved in energy R&D, to speak on energy policy, outline his plans and blast his critics.<sup>13</sup>

Obama's plans and programs in energy, science and technology are being developed and implemented by the strongest science and technology team of any administration in recent memory. Steven Chu, Nobel laureate in physics (1997) and former director of Lawrence Berkeley National Laboratory, holds the key position of Secretary of Energy. John Holdren, director of the Program in Science, Technology and Public Policy at the Kennedy School of Government at Harvard University, director of the Woods Hole Research Center, and one of the nation's top experts on climate change, is Assistant to the President for Science and Technology and Director of the White House Office of Science and Technology Policy. Jane Lubchenco, distinguished marine ecologist on the faculty of Oregon State University and winner of many prizes and awards for her research, is Administrator of the National Oceanic and Atmospheric Administration (NOAA) and Under Secretary of Commerce for Oceans and Atmosphere. Marcia McNutt, former president and chief executive officer of the Monterey Bay Aquarium Research Institute, is directing the U.S. Geological Survey. And Francis Collins, one of the world's best-known geneticists and former director of the National Human Genome Research Institute, was appointed Director of the National Institutes of Health. Together, these individuals, and many others with excellent scientific and engineering credentials, make up an unusually strong team, backing the President's ambitious agenda.

## 5. THE OBAMA PROGRAM FOR GREEN TECHNOLOGY INNOVATION<sup>14</sup>

The green technology investments in the Recovery Act include substantial boosts in federal energy R&D spending as well as incentives for production and consumption of green energy, including tax credits and loan guarantees. Estimates of the amount of money being allocated to green technology and the number of "green jobs" being created vary significantly.<sup>15</sup> Virtually every federal agency that received stimulus money claims to be spending some of it on projects that can be considered "green." The National Park Service is investing a portion of its stimulus appropriation in the purchase of energy efficient equipment, such as alternative fuel and hybrid buses. The Department of Transportation is providing funds to local jurisdictions to assist them in reducing greenhouse gases emitted by transit systems. The National Institute of Standards and Technology (NIST) is using a portion of its funds to support measurement science and engineering relating to energy, environment, and climate change. And NASA is using its funding to accelerate research in earth sciences, by supporting

---

<sup>13</sup> Remarks by the President Challenging Americans to Lead the Global Economy in Clean Energy, Massachusetts Institute of Technology, Boston, Massachusetts, October 23, 2009. <http://www.whitehouse.gov/the-press-office/remarks-president-challenging-americans-lead-global-economy-clean-energy>.

<sup>14</sup> A representative sample of the administration's green technology efforts is described in this section. A complete inventory would take far too much space and is, in any case, a moving target.

<sup>15</sup> Some examples: "Of the \$787 billion included in the economic stimulus package signed into law by President Obama on February 17, 2009, just under \$79 billion will go to renewable energy, energy-efficiency and green transportation projects." (<http://www.buildinggreen.com/auth/article.cfm/2009/3/26/Federal-Stimulus-Will-Fund-Green-Building/>) "The bill contains at least \$62.2 billion in direct spending on green initiatives and \$20 billion in green tax incentives. . ." (<http://www.grist.org/article/A-green-tinged-stimulus-bill/>) "Unprecedented investments in clean energy are a central element of the recovery plan. The bill includes \$71 billion for clean energy programs [and] \$20 billion in clean energy tax incentives." ([http://www.americanprogress.org/issues/2009/02/recovery\\_plan\\_captures.html](http://www.americanprogress.org/issues/2009/02/recovery_plan_captures.html)).

TABLE 1. Recovery Act Funding in the Department of Energy by Functional Area

Unit	Amount (Billions)
Energy Efficiency and Renewable Energy	\$ 16.8
Environmental Management <sup>1</sup>	\$ 6.0
Electricity Delivery & Energy Reliability <sup>2</sup>	\$ 4.5
Loan Guarantee Program Office <sup>3</sup>	\$ 4.0
Fossil Energy <sup>4</sup>	\$ 3.4
Office of Science <sup>5</sup>	\$ 1.6
ARPA-E	\$ 0.4
Total	\$ 36.7

Source: U.S. Department of Energy <http://www.energy.gov/recovery/>  
 All figures are rounded to the nearest tenth of a billion.

- 1\_Clean up of Cold War nuclear sites
- 2\_Smart grid and efficient electrical transmission
- 3\_Loan guarantees for renewable energy
- 4\_Carbon capture and storage
- 5\_Basic and applied research

earth observation satellites, airborne systems and R&D in environmental impact mitigation under its aeronautics program.

Not surprisingly, however, it is the Department of Energy (DOE) that is leading the government’s efforts in green technology and carrying the greatest responsibility for those efforts. DOE received \$36.7 billion in Recovery Act funds – \$3 billion more than its total FY 2009 budget of \$33.7 billion. Table 1 shows the distribution of DOE’s Recovery Act funding by functional area. Nearly half of DOE’s funding (\$16.8 billion) is devoted to programs in energy efficiency and renewable energy (EERE).

Not all of EERE’s programs are high-tech. Much of the money in the energy efficiency and renewable energy category is being devoted to programs that use existing technologies and will quickly create jobs and provide immediate benefits in energy savings. Through the Weatherization Assistance Program a total of \$5 billion in grants is being distributed to state agencies for the provision of weatherization services to the homes of low income people. The program, which operates through contracts to private businesses that provide the services, employs low-cost, low-tech measures to improve the energy efficiency of these buildings at no cost to their owners. The measures taken include improvements ranging from sealing leaks in air distribution systems to adding insulation to walls and attics. According to DOE, weatherization can reduce energy consumption in a single-family home by 12 to 23 percent or more.<sup>16</sup> An additional \$3.1 billion is going to the State Energy Program, which provides grants to states to assist them in addressing their energy priorities and provides funding for the adoption of emerging renewable energy and energy efficiency technologies.<sup>17</sup> Additionally, over \$3 billion is being allocated, mostly by formula, to energy efficiency and conservation block grants to states, territories, local governments, and Indian tribes.

<sup>16</sup> U.S. Department of Energy, “Technology Focus: Single-Family Residential Building Weatherization.” <http://www1.eere.energy.gov/femp/pdfs/WeatherizTF.pdf>.

<sup>17</sup> U.S. Department of Energy, “State Energy Program.” [http://apps1.eere.energy.gov/state\\_energy\\_program/](http://apps1.eere.energy.gov/state_energy_program/).



TABLE 2 DOE Research Programs in Energy Efficiency and Renewable Energy

Program	Amount (Millions)
Applied Research, Development, Demonstration, and Deployment	\$ 2,453.4
BIOMASS	\$ 786.5
GEOTHERMAL TECHNOLOGIES	\$ 350.0
GEOTHERMAL HEAT PUMPS	\$ 50.0
ENERGY EFFICIENT BUILDING TECHNOLOGIES	\$ 346.0
INDUSTRIAL TECHNOLOGIES PROGRAM	\$ 206.0
SOLAR TECHNOLOGIES PROGRAM	\$ 117.6
VEHICLE TECHNOLOGIES PROGRAM	\$ 110.0
NATIONAL LABORATORY FACILITIES	\$ 104.7
FACILITY AND INFRASTRUCTURE IMPROVEMENT AT THE NATIONAL RENEWABLE ENERGY LABORATORY	\$ 100.7
WIND ENERGY PROJECTS	\$ 93.0
INFORMATION AND COMMUNICATIONS TECHNOLOGY	\$ 50.0
SPUR GROWTH OF FUEL CELL MARKETS	\$ 41.9
MODERNIZING HYDROPOWER INFRASTRUCTURE, INCREASING EFFICIENCY, & REDUCING ENVIRONMENTAL IMPACT	\$ 32.0
MASSACHUSETTS WIND TECHNOLOGY TESTING CENTER	\$ 25.0
COMMUNITY RENEWABLE ENERGY DEPLOYMENT	\$ 22.0
SMALL BUSINESS CLEAN ENERGY INNOVATION PROJECTS	\$ 18.0
Advanced Battery Manufacturing Grants	\$ 2,000.0
Transportation Electrification	\$ 400.0
Total	\$ 4,853.4

Source: U.S. Department of Energy <http://www1.eere.energy.gov/recovery/>  
 All figures are rounded to the nearest tenth of million.

Other EERE grant programs aimed at subsidizing the adoption of green energy technologies include \$300 million for the “Clean Cities” program, a competitive grants program under which DOE is sharing with states and cities around the country the cost of deploying alternative fuel vehicles (including hybrids and vehicles that run on ethanol, electricity, and compressed natural gas) and establishing refueling stations for them. Another \$300 million program, also administered by states, is providing rebates to consumers for purchasing energy-efficient refrigerators, washers, air conditioners, water heaters, and other appliances.

In addition to programs such as these that encourage the adoption of existing and near-term technologies, nearly \$5 billion is being invested in programs with a longer time horizon - applied research, development, demonstration, and deployment of more advanced technologies. Table 2 lists these programs.

Examples of the projects being funded under the heading of solar technologies include \$51.5 million for photovoltaic technology development—strengthening the capabilities and competitiveness of domestic manufacturers and reducing the cost of solar electricity—and \$40.5 million for solar energy deployment focusing on non-technical barriers such as grid connection, market barriers, and shortages of trained solar installers.

<sup>18</sup> U.S. Department of Energy, “Over \$467 Million in Funding Announced for Geothermal and Solar,” May 27, 2009. [http://apps1.eere.energy.gov/news/daily.cfm/hp\\_news\\_id=167](http://apps1.eere.energy.gov/news/daily.cfm/hp_news_id=167)

According to DOE, the \$350 million being invested in geothermal energy technology dwarfs previous government commitments.<sup>18</sup> Nearly a fourth of this amount (\$80 million) is going into R&D on “enhanced geothermal systems” in which water is pumped down wells into hot dry rock, heated, and forced to the surface where it can be used in steam turbines or other power systems. This makes it possible to generate geothermal electricity in many locations that do not have naturally-occurring hydrothermal resources. Another \$140 million is being invested in geothermal energy demonstration projects using innovative technologies and expanding to areas that cannot be exploited with conventional techniques.

The largest single component of EERE’s research, development and demonstration programs (\$800 million) is in biomass, an area in which DOE has already made a significant investment. Included here is funding for new projects, as well as increased funding for existing ones. Among them are both pilot-scale and demonstration-scale projects (at nearly half a billion dollars) to validate biorefinery technologies, so as to enable privately-financed enterprises to replicate these systems commercially. Other elements of the biomass program include \$110 million for fundamental research, about half of which will go to the study of algae-based biofuels.<sup>19</sup>

One of the R&D programs that have attracted the most interest is the \$2.4 billion being invested in advanced battery manufacturing and electric drive vehicles, an effort announced by President Obama during a visit to Navistar International Corporation in Indiana. Navistar manufactures trucks, buses, recreational vehicles, and parts for various vehicles, and the President announced a \$39 million grant to help the firm begin manufacturing electric trucks. Other sizeable grants are supporting the development of a manufacturing base for new battery technologies and their components, for battery recycling capacity, and for electric vehicle components.<sup>20</sup> Finally, \$400 million in grants is being devoted to the purchase of plug-in hybrid and all-electric vehicles for test demonstrations in a variety of locations, for evaluation of their performance, and for installation of electric charging infrastructure. As part of this effort, a number of universities are also receiving funding for education and workforce training to provide a base of human resources for the transition to electric vehicles.

Elsewhere in the Department of Energy, \$4.0 billion is allocated to the Loan Guarantee Program, a program authorized under the Energy Policy Act of 2005 which gives DOE authority to issue loan guarantees to projects that “avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases” and “employ new or significantly improved technologies.” Examples of loans guaranteed under this program include \$245 million to a factory in Louisiana that will produce activated carbon, a technology used for reducing mercury emissions from coal-fired power plants and \$535 million to a California-based firm that manufactures innovative cylindrical solar photovoltaic panels.

The Office of Fossil Energy is receiving \$3.4 billion, of which about \$1 billion has been allocated to the FutureGen Industrial Alliance, a consortium of coal mining and electric utilities that is intended to demonstrate the feasibility of producing electricity while capturing and sequestering carbon dioxide emissions. The project was originally announced by President George W. Bush in 2003, then abandoned by the Bush Administration because of projected cost overruns.<sup>21</sup> Obama has

---

<sup>19</sup> U.S. Department of Energy, “DOE Announces Nearly \$800 Million from Recovery Act for Biofuels,” May 05, 2009. [http://apps1.eere.energy.gov/news/daily.cfm/hp\\_news\\_id=164](http://apps1.eere.energy.gov/news/daily.cfm/hp_news_id=164).

<sup>20</sup> U.S. Department of Energy, “Recovery Act Awards for Electric Drive Vehicle Battery and Component Manufacturing Initiative.” n.d. [http://www1.eere.energy.gov/recovery/pdfs/battery\\_awardee\\_list.pdf](http://www1.eere.energy.gov/recovery/pdfs/battery_awardee_list.pdf).

<sup>21</sup> Ben Geman and Greenwire, “DOE Revives FutureGen, Reversing Bush-Era Decision,” *The New York Times*, June 12, 2009. <http://www.nytimes.com/gwire/2009/06/12/12greenwire-doe-revives-futuregen-reversing-bush-era-decis-47303.html>.

resurrected the project and will fund design and analysis efforts, with a decision scheduled for early 2010 on whether to proceed with construction. Another \$1.5 billion is being invested in a number of cost-shared government-industry projects aimed at demonstrating processes that will capture and sequester or re-use carbon dioxide from industrial sources. And \$800 million will go to DOE's Clean Coal Initiative, leveraging \$2.2 billion in private capital, for other carbon capture and sequestration projects involving electric utilities.

The task of seeking out and funding the “transformative” research that the Obama Administration hopes will revolutionize the field of energy in the future has been assigned to a new DOE unit created under the America COMPETES Act of 2007, the Advanced Research Projects Agency-Energy, better known as ARPA-E. Self-consciously modeled on DARPA, the Defense Advanced Research Projects Agency, which is known for its “out of the box” thinking and which is generally credited with the invention of the Internet, ARPA-E originated in a recommendation of the National Academy of Sciences’ influential report on innovation, *Rising Above the Gathering Storm*.<sup>22</sup> The idea is to apply the same kind of cross-disciplinary techniques and organizational culture to energy R&D that DARPA has used in the defense arena. Like DARPA, ARPA-E is expected to support high-risk, high-payoff research that other agencies and units of DOE are unlikely to take on because of the risk of failure. Although it was created in 2007, ARPA-E was not given a budget initially. The Obama Administration has allocated \$400 million under the stimulus program to begin operations.

ARPA-E issued its first funding opportunity announcement in late April 2009. In response, it received an astonishing 3,700 concept papers, 334 of which were turned into full proposals. From among these proposals, the agency announced on October 26, 2009, that it had selected 37 for funding, representing a total of \$151 million—an average of over \$4 million per project. Among these projects is a \$7 million effort at MIT to develop a liquid metal battery cheap and effective enough that it could be used as part of the nation’s energy grid, making solar and wind energy available around-the-clock and helping to stabilize the grid. A \$2.25 million project at the United Technologies Research Center will use a synthetic version of an enzyme used by the human body to remove carbon dioxide to capture CO<sub>2</sub> emissions from power plants and industrial sources. And a \$4.5 million grant to Momentive Performance Materials, Inc. will support a novel crystal growth technology that could sharply lower the cost of LEDs (light emitting diodes) that are being developed as replacements for incandescent and fluorescent bulbs.<sup>23</sup>

Another \$100 million competition was announced by the agency in December 2009. ARPA-E sees its mission as being a catalyst for a major transformation in the nation’s energy system—not in the far-distant future, but in the next ten to twenty years. In order to do that it is willing to take risks and entertain the prospect of failure in many of its projects. If it succeeds in even a fraction of its efforts, it could have an historic impact.

---

<sup>22</sup> National Academy of Sciences, Committee on Science, Engineering and Public Policy, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academy Press, 2007).

<sup>23</sup> U.S. Department of Energy, “Transformational Energy Research Projects Win \$151 Million in Funding,” press release, October 26, 2009. <http://arpa-e.energy.gov/public/PR-102609.pdf>.

## 6. THE POLITICAL CONTEXT OF GREEN INNOVATION

For advocates of green technology, these federal investments are exciting and long overdue. Scientific advances as well as recent data on global climate change and the growing international consensus regarding its potential consequences have given increased urgency to the notion of federal support for the development and implementation of green technology in the private sector. The idea of such an initiative, however, is not new. There is, in fact, a long history of federal efforts to promote renewable energy technology and an even longer history of federal programs intended to accelerate innovation in the private sector. And both histories have often been marred by bitter political controversies. It is in this context that one must view the Obama Administration's ambitious program of green technology innovation.

Among the program's most vocal critics are the global warming skeptics (e.g., Senator James Inhofe, Republican of Oklahoma) who consider taxes on energy consumption, cap-and-trade programs and large-scale government expenditures on programs that are intended to reduce greenhouse gas emissions to be misguided and a waste of money. Many of the critics have vested interests in the current energy picture—e.g., coal and oil producers—and stand to lose financially or politically from a shift to renewable sources. Others simply do not believe the science. They feel that the potential impacts of warming have been exaggerated and the problem does not require drastic actions, or believe that, if adjustments are needed, the market will take care of them.<sup>24</sup>

Other critics of the administration's green technology plans oppose government programs aimed at stimulating all forms of innovation in the private sector. This perspective is characterized by a belief that government involvement in commercial innovation is ineffective, interferes with the market system, and generally results in wasteful government spending.<sup>25</sup> In fact, there is considerable overlap among the two groups, both of which regard themselves as politically conservative and are most strongly represented on the Republican side of the aisle.

Since the election of 2008, in which the Democrats took control of the White House and gained substantial majorities in both houses of Congress, virtually all areas of American politics have become increasingly polarized. This polarization may be seen in the debate over reform of the American health care system, in the battles between Democrats and Republicans over economic policy, in opposition to the President's efforts to align the United States with those nations who have pledged substantial reductions in greenhouse gas emissions, and in the difficulties he and his congressional allies have had in moving a cap-and-trade bill through Congress. It could be heard during the 2008 Republican convention with the loud choruses of "Drill, baby, drill" emanating from delegates advocating the exploitation of offshore oil resources rather than investment in conservation and development of alternative energy sources.<sup>26</sup> And it can be seen, most vividly, in the highly partisan split on the stimulus bill. Not a single one of the 178 Republican Members of the House of Representatives and only two of the 40 Republican Senators voted for the final bill. The administration's green tech-

---

<sup>24</sup> See, for example, S. Fred Singer, "The Great Global Warming Swindle," *San Francisco Examiner* (May 22, 2007), available online at <http://www.independent.org/newsroom/article.asp?id=1945>.

<sup>25</sup> Brian M. Riedel, "The Advanced Technology Program: Time to End this Corporate Welfare Handout," *Heritage Foundation Backgrounder #1665* (July 15, 2003). Available at <http://www.heritage.org/research/budget/bg1665.cfm>.

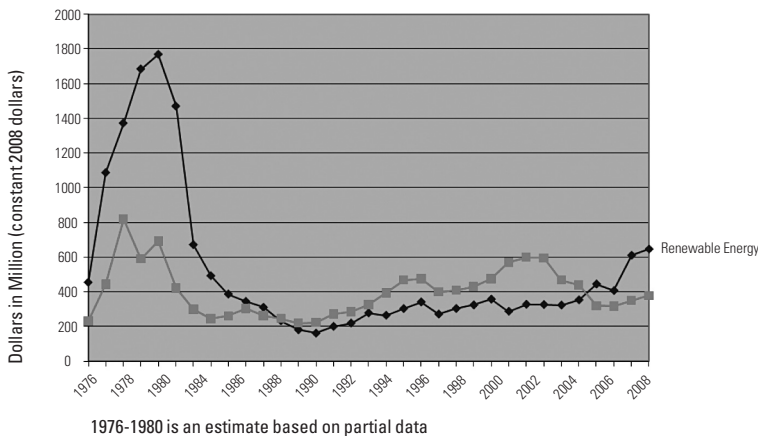
<sup>26</sup> Siobhan Hughes, "Steele Gives GOP Delegates New Cheer: 'Drill, Baby, Drill!'" *Wall Street Journal Blogs* (September 3, 2008). Available at <http://blogs.wsj.com/washwire/2008/09/03/steele-gives-gop-delegates-new-cheer-drill-baby-drill/>.

nology innovation programs represented a relatively small part of the bill and its \$787 billion price tag, but they were certainly among the provisions that conservative Members found objectionable.

## 7. A BRIEF POLITICAL HISTORY OF RENEWABLE ENERGY R&D

The left-right split on energy policy goes back to the mid-1970s and probably earlier. Oil production in the United States peaked around 1970 and began to decline, while consumption, thanks to the growth of imported oil, continued to increase. Although these trends did not go unnoticed by scholars, think tanks, and some policymakers even before that time,<sup>27</sup> it was the 1973 oil embargo and subsequent price shock that dramatically raised the salience of the issue with the American public and their leaders. Responding to public pressure, President Richard Nixon, a Republican, launched “Project Independence” in 1974. Not to be outdone, the Democrat-controlled Congress subsequently took the lead in energy policy.<sup>28</sup> In October 1974 Congress created the Energy Research and Development Administration (ERDA) by splitting the former U.S. Atomic Energy Commission into two parts: ERDA, responsible for energy R&D (including nuclear weapons) and the Nuclear Regulatory Commission (NRC), responsible for regulating the commercial nuclear power industry. As part of the reorganization, ERDA absorbed the coal research programs of the Interior Department, as well as the solar and geothermal energy research programs of the National Science Foundation. Ultimately, under ERDA, the U.S. began to shift the focus of its energy R&D from nuclear energy and coal to renewable sources and conservation.

FIGURE 1  
RENEWABLE ENERGY AND CONSERVATION R&D BY YEAR, FY 1976-2008



<sup>27</sup> A Time to Choose: America’s Energy Future, Final Report of the Energy Policy Project of the Ford Foundation (Cambridge: Mass.: Ballinger Publishing Company, 1974).

<sup>28</sup> Ronald Bailey, “Energy Independence: The Ever-Receding Mirage” Reason.com (July 21, 2004). <http://reason.com/archives/2004/07/21/energy-independence-the-ever-r>.

<sup>29</sup> Ibid.

Although President Gerald Ford, who succeeded Nixon after his resignation in 1974, was supportive of renewable energy, it was again the Democrats in Congress who took the initiative in energy policy and gave a major boost to solar, geothermal, conservation, and other renewables in the mid-1970s. As Figure 1 shows, R&D on energy conservation more than doubled between fiscal year 1976 and 1977, while solar and geothermal R&D nearly tripled in that period. Congressional Republicans objected to the large increases, but were outvoted. Research on fossil fuels and nuclear energy also received increases, but not of the same magnitude.

President Jimmy Carter, who succeeded Ford in January 1977, made energy policy “the centerpiece of his administration.”<sup>29</sup> He declared that achieving energy independence was “the moral equivalent of war” and, with the aid of the Democratic Congress, further increased support for renewable energy R&D. His FY 1978 budget called for \$310 million in conservation R&D compared to \$74.7 million just two years earlier, and \$305 million in solar energy R&D, up from \$114.7 million in FY 1976. During his administration Congress created a Department of Energy with the Energy Research and Development Administration as its nucleus. Carter also created a \$20 billion demonstration program to promote the development of synthetic fuels (Synfuels) to replace imported oil. The continued growth in energy R&D took place against the backdrop of a second sharp increase in the price of oil triggered by the Iranian Revolution of 1979. By 1980, the price of a barrel of oil had skyrocketed to over \$37, which, in inflation-adjusted 2009 dollars, is the equivalent of nearly \$100 a barrel.<sup>30</sup>

The year 1981, however, marked an inflection point in both the price of oil and in the federal government’s support for energy R&D. Oil prices began a steep decline, reaching a low in 1986 of just over \$14 a barrel (\$28 in 2009 dollars, after adjusting for inflation) and with them, popular support for large investments in energy R&D and demonstration programs also began to wane. The election of President Ronald Reagan, a conservative Republican, together with a Republican majority in the Senate, sealed the fate of most of President Carter’s ambitious initiatives. Reagan proposed cutting solar energy R&D from \$597 million in FY 1981 (under Carter) to \$193 million in FY 1982, drastically scaling back many programs, such as wind energy, and completely eliminating others. His request for energy conservation R&D in FY 1982 was \$88 million, down from \$276 million the previous year. These reductions and others were partly offset by increases in nuclear energy research. With Democrats still in control of the House of Representatives, there ensued a tug-of-war between the Reagan Administration and Democrats contesting the cuts. The result was, as is frequently the case in American politics, a compromise. Solar received \$268 million, considerably more than the President had requested but less than half of the level of the previous year. The final budget for energy conservation was \$152 million instead of the \$88 million request.<sup>31</sup>

The see-saw battle over renewable energy R&D has continued since the 1980s with Democrats generally advocating additional investments and Republicans generally resisting. President Bill Clinton proposed modest increases in solar energy R&D and more substantial growth in conservation, which included one of his administration’s signature initiatives, the Partnership for a New Generation of Vehicles (PNGV), a collaborative program between the federal government and U.S.

---

<sup>30</sup> Inflation.com, “Historical Crude Oil Prices (Table).”

<sup>31</sup> Data in this section are from AAAS Reports VI through VIII: Research and Development FY 1982, 1983, and 1984 (Washington, DC: American Association for the Advancement of Science, 1981-83).

automakers to develop a more efficient automobile. Clinton's efforts to expand renewable energy and conservation R&D were largely thwarted, however, when Republicans took control of both houses of Congress in 1995 with what they regarded as a mandate to slash federal spending. Among the many cuts they made—moderated to some extent by opposition from the President and the Democratic minority—were reductions in renewable energy and conservation R&D. The lengthy budget battle that year yielded a cut of more than 25 percent in solar and 13 percent in conservation.<sup>32</sup> Similar contests took place virtually every year through the administration of George W. Bush (whose energy policy was largely focused on more drilling to expand supplies of oil), with the White House proposing cuts in conservation and renewable energy R&D and congressional Democrats and Republicans battling over them. As a result of this stalemate, federal funding for renewable energy and conservation R&D has stagnated through the past two decades. Figure 1 illustrates the up and down pattern of funding throughout this period. Against this background, one can view the energy R&D initiatives in the stimulus bill as the Democrats taking advantage of the economic emergency and growing concern over global climate change at a time during which they control the White House and both houses of Congress to implement the kinds of programs they have advocated with mixed success since the 1970s. The question this time is whether the current initiatives will survive the inevitable swing of the political pendulum or whether they will once again fall victim to budget pressures and political opposition.

## 8. THE POLITICS OF FEDERAL INNOVATION POLICY

How active a role should the federal government play in stimulating innovation in the private sector? How far should it go toward subsidizing the development of products and processes for the private sector through applied research, development, and demonstration? These are questions that have bedeviled American policymakers for close to 100 years.<sup>33</sup> There is a broad consensus across the political spectrum in the U.S. about the importance of federal support for basic research. It is generally understood and widely accepted that basic research is essential to a healthy innovation system and that the free market system—that is to say, private firms—will not support a socially optimal amount.<sup>34</sup> The federal government's role is to fill the gap left by this market failure and the government does this by providing about \$30 billion a year (in FY 2009), largely through grants to universities and other not-for-profit institutions. Throughout the post-World War II era, the consensus on the value of this investment in basic research has been sustained, with some ups and downs, through numerous Republican and Democratic administrations and Congresses with political coloration ranging from strongly liberal to strongly conservative.

There is also little dispute among political leaders over the need for government to fund applied

---

<sup>32</sup> Kei Koizumi et al., *Congressional Action on Research and Development in the FY 1996 Budget* (Washington, DC: American Association for the Advancement of Science, 1996), p. 27.

<sup>33</sup> Hart (1998).

<sup>34</sup> Smith (1990).

research and development *in support of its own needs and missions*. These needs and missions include, for example, defense, in which the U.S. invests nearly \$86 billion a year (FY 2009) for research, development, testing, and evaluation. In these instances, the government is the client for the products of the R&D it sponsors, so while there is considerable room for argument over the amount of money that it should spend and the specifics of its programs, the argument is generally over the priority of the overall defense mission relative to other government missions and not the propriety of the government investing in R&D as a means of serving that mission.

The political consensus breaks down, however, when it comes to federal support of applied research and development that is specifically intended to produce technologies that will be commercialized in the private sector. And that, of course, is precisely the case with most of the Obama Administration's program of green technology innovation. The liberal (Democratic) view is that support of applied research and development is necessary when it is a public good—that is, it serves an important purpose for society that is not likely to be served by the market. In this view, federal support is essential for bridging “the valley of death” between initial, relatively small-scale funding for promising ideas and the much more substantial amount of investment needed to commercialize those ideas. In some realms—for example, biomedical research and aviation safety—federal support for most applied research is relatively non-controversial. In others, however, there is little agreement across the political spectrum. One such realm is R&D aimed at supporting American industrial competitiveness. Another is green energy technology.

Nothing illustrates the ideological divide over competitiveness-related research better than the two-decade long battle over a relatively minor program in the National Institute of Standards and Technology (NIST) of the Department of Commerce originally known as the Advanced Technology Program (ATP), more recently reborn as the Technology Innovation Program (TIP).<sup>35</sup> It's worth reviewing the history of this program because, in a broad sense, its aims parallel many parts of the Obama Administration's green technology innovation efforts.

*Sounding much like the new ARPA-E, TIP describes its mission as follows:*

The Technology Innovation Program (TIP) supports, promotes, and accelerates innovation in the United States through high-risk, high-reward research in areas of critical national need. TIP has the agility and flexibility to make targeted investments in transformational R&D that will ensure our Nation's future through sustained technological leadership.<sup>36</sup>

TIP's predecessor, ATP, was initiated in 1990 with the modest budget of \$10 million in response to concerns about declines in American technological competitiveness relative to other industrialized nations, especially Japan and the so-called “Asian Tigers.” Like its successor, ATP focused on high risk research. It sought to support R&D projects that would have a significant impact on the nation's economy, but unlike TIP, it did not focus its efforts strictly on “areas of critical national need.” Popular with Congressional Democrats and some Republicans, ATP grew to \$68 million by the end of the administration of President George H.W. Bush.<sup>37</sup>

---

<sup>35</sup> National Institute of Standards and Technology, Technology Innovation Program home page. <http://www.nist.gov/tip/>.

<sup>36</sup> Ibid.

<sup>37</sup> Glenn R. Fong, “Repositioning the Advanced Technology Program,” *Issues in Science & Technology* (Fall 2001) <http://www.issues.org/18.1/fong.html>. See also, Christopher T. Hill, “The Advanced Technology Program: Opportunities for Enhancement,” pp. 143-179 in Lewis M. Branscomb and James H. Keller, *Investing in Innovation: Creating A Research and Innovation Policy That Works* (Cambridge, Mass.: MIT Press, 1998).



When President Bill Clinton and Vice President Al Gore came to power in 1993, they decided to highlight the program, making it a cornerstone of their economic agenda and their efforts to strengthen U.S. international competitiveness. In his Fiscal Year 1994 budget, Clinton tripled the program's funding from \$64 to \$188 million and announced plans to expand it to \$1.5 billion over the next several years—an effort pursued by and strongly identified with Vice President Gore.<sup>38</sup> By FY 1995, ATP's budget had grown to over \$400 million.

ATP's fortunes changed radically, however, when a newly-elected Republican majority came to power in Congress in 1995 with an agenda that included slashing federal spending and eliminating government programs that, in their view, interfered with the operations of the free market. In fact, the new Congress passed legislation abolishing the entire Department of Commerce (ATP's parent agency) but President Clinton vetoed it. Though they failed in that effort, Republican leaders in Congress targeted a number of individual Commerce Department programs, including ATP, for elimination. A last-minute compromise averted that fate, but ATP's R&D budget was cut to \$208 million, less than half the administration's request. This scenario was repeated every year for the balance of the Clinton Administration, with the President proposing an increased budget, Republicans in Congress threatening to kill the program entirely, and the two sides, in the end, compromising on a budget somewhat smaller than the previous year.

The battle over ATP did not end with the election of Republican George W. Bush in 2000. Bush, like his Republican colleagues in Congress, each year sought to eliminate the program, but each year the program's advocates fought to preserve it. By the end Bush's first term, ATP had shrunk to around \$100 million a year, a far cry from Clinton and Gore's ambitious plans. In 2007, as part of the America COMPETES Act, Congress terminated ATP and replaced it with TIP.<sup>39</sup> Despite this change, which added the focus on areas of critical national need, the Bush Administration continued its efforts to zero out the program. By FY 2008, TIP's budget shrank to \$46 million. President Obama reversed his predecessor's policy and, instead of proposing TIP's elimination, requested a modest budget increase to \$70 million in FY 2010, part of an effort to double the budget for the National Institute of Standards and Technology (NIST), as planned in the America COMPETES Act.

## 9. CONCLUSIONS: THE FUTURE OF THE OBAMA GREEN TECHNOLOGY PROGRAMS

The Obama Administration has put forth an extraordinarily ambitious set of goals for itself in green technology innovation. If this were the only major item on its plate at the present time, it would be difficult enough to achieve these goals. But the administration is simultaneously seeking to restore the U.S. economy, negotiate an international climate change agreement, reform the nation's health care system, protect the nation from terrorist attack, reform U.S. immigration policy, and fight increasingly unpopular wars in Iraq and Afghanistan. Whether it has enough political capital to accomplish its green technology goals in this context is very much an open question.

The scale and scope of the administration's investment in green energy technology innovation is unprecedented. To those who accept the current scientific consensus on climate change, the size of

---

<sup>38</sup> Ibid.; Intersociety Working Group, AAAS Report XIX: Research and Development FY 1995 (Washington, DC: American Association for the Advancement of Science, 1994), p. 126; Table II-14.

<sup>39</sup> [http://science.house.gov/legislation/leg\\_highlights\\_detail.aspx?NewsID=1938](http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1938)

the program seems warranted, and its inclusion within the package of measures designed to create jobs and address the nation's current economic woes may help to make it more palatable to potential critics who might view some of its elements with a skeptical eye. Nevertheless, the Obama green technology agenda faces several major hurdles.

One obvious issue is inherent in the nature of the stimulus: it is a one-time special appropriation. The funds will not go into the agencies' budget base from which future increases or decreases will be determined. In other words, DOE's FY 2010, 2011, and other future budgets will not take account of ARRA funds. Contracts, grants, loan guarantees, and other forms of federal support may be expended over several years. But once those funds are gone, DOE (and other agencies with Recovery Act funding) will need to decide between supporting the stimulus-funded projects that need and deserve additional funding and their portfolios of projects funded under its regular appropriations. Some promising stimulus-funded efforts, especially those funded through public-private partnerships (as many are) may be taken over by collaborating private sector entities. But others, needing continued government support to reach fruition, will find themselves in stiff competition for ongoing support within a much tighter budget environment.

Complicating the budget situation further is the record budget deficit— \$1.4 trillion in FY 2009—created by the combination of stimulus spending and tax cuts and the decline in government revenues due to the recession. And the deficit is projected to be even greater in FY 2010. Political pressure to reduce the deficit is growing and Congress and the administration will need to respond, most likely by holding down or cutting spending in future years. Although Congress treated DOE's energy technology programs well in the FY 2010 budget process, rumors abound that FY 2011 is going to be much more difficult.

Green technology programs may encounter even rougher sailing in FY 2012. The President's FY 2012 budget will be submitted in February 2011, shortly after the next Congress, which will be elected in November 2010, is seated. The party in the White House almost always loses seats in mid-term elections and most observers expect that the Democrats' strong majorities in the House and Senate will be significantly reduced in this election. That, combined with the tight budget situation and the likelihood, based on past experience, that the new Congress will be more conservative and less friendly both to green technology and government programs that seek to accelerate private sector innovation, could well cause the pendulum to swing away from renewable energy and conservation programs and back toward increased exploitation of fossil fuel resources and/or nuclear energy.

Finally, there is the matter of the demand for green technologies. Several factors will influence demand. First, and probably foremost, is the price of fossil fuels, especially petroleum. While prices have moderated in the past year or two because of the global economic slowdown, once the world's economies begin to recover and demand for oil increases, prices will surely rise. They will be driven further by growing demand from China and India, making renewable energy sources and conservation look like increasingly attractive alternatives. Passage of a cap-and-trade bill in the U.S. and a more rigorous international agreement to limit emissions would further enhance the attractiveness of renewables and conservation. One of President Obama's proposals during the presidential campaign was to invest a major portion of the revenues that the government would receive from selling emissions allowances in energy research. The figure of \$150 billion over ten years was widely quoted. Congress, should it manage to pass a cap-and-trade bill, is likely to have other ideas on how to spend those revenues. Still, even without this money, a bill limiting emissions would be a major boon to green technology innovation.

## REFERENCES

- "A Time to Choose: America's Energy Future". *Final Report of the Energy Policy Project of the Ford Foundation*. Cambridge, Mass.: Ballinger Publishing Company, 1974.
- American Association for the Advancement of Science. "AAAS Reports VI through VIII: Research and Development FY 1982, 1983, and 1984." Washington, DC: American Association for the Advancement of Science, 1981-83.
- Bailey, Ronald. "Energy Independence: The Ever-Receding Mirage" *Reason.com* July 21, 2004. <http://reason.com/archives/2004/07/21/energy-independence-the-ever-r>.
- Building Green.com. <http://www.buildinggreen.com/auth/article.cfm/2009/3/26/Federal-Stimulus-Will-Fund-Green-Building/>.
- Center for American Progress. [http://www.americanprogress.org/issues/2009/02/recovery\\_plan\\_captures.html](http://www.americanprogress.org/issues/2009/02/recovery_plan_captures.html).
- Climate Science Watch. "Climate change and sustainable energy in President Obama's proposed FY 2010 budget." [http://www.climate-science-watch.org/index.php/csw/details/obama\\_fy2010\\_budget\\_climate\\_energy/](http://www.climate-science-watch.org/index.php/csw/details/obama_fy2010_budget_climate_energy/).
- CNN.com. "Obama's Remarks on Signing the Stimulus Plan," February 17, 2009. <http://www.cnn.com/2009/POLITICS/02/17/obama.stimulus.remarks/>
- CNNPolitics.com Election Center, Issue Tracker. <http://www.cnn.com/ELECTION/2008/issues/>.
- Fong, Glenn R. "Repositioning the Advanced Technology Program." *Issues in Science & Technology*, Fall (2001) <http://www.issues.org/18.1/fong.html>.
- Geman, Ben, and Greenwire. "DOE Revives FutureGen, Reversing Bush-Era Decision." *The New York Times*, June 12(2009). <http://www.nytimes.com/gwire/2009/06/12/12greenwire-doe-revives-futuregen-reversing-bush-era-decis-47303.html>.
- Grist.org. <http://www.grist.org/article/A-green-tinged-stimulus-bill/>.
- Hart, David M. *Forged Consensus: Science, Technology and Economic Policy in the United States, 1921-1953*. Princeton, NJ: Princeton University Press, 1998.
- Hill, Christopher T. "The Advanced Technology Program: Opportunities for Enhancement." pp. 143-179 in Lewis M. Branscomb and James H. Keller, *Investing in Innovation: Creating A Research and Innovation Policy That Works*. Cambridge, Mass.: MIT Press, 1998.
- Hughes, Siobhan. "Steele Gives GOP Delegates New Cheer: 'Drill, Baby, Drill!'" *Wall Street Journal Blogs* (September 3, 2008). Available at <http://blogs.wsj.com/washwire/2008/09/03/steele-gives-gop-delegates-new-cheer-drill-baby-drill/>.
- Inflation.com. "Historical Crude Oil Prices (Table)." [http://www.inflationdata.com/inflation/Inflation\\_Rate/Historical\\_Oil\\_Prices\\_Table.asp](http://www.inflationdata.com/inflation/Inflation_Rate/Historical_Oil_Prices_Table.asp).
- Intersociety Working Group. *AAAS Report XIX: Research and Development FY 1995*. Washington, DC: American Association for the Advancement of Science, 1994.
- Koizumi, Kei et al. *Congressional Action on Research and Development in the FY 1996 Budget*. Washington, DC: American Association for the Advancement of Science, 1996.
- National Academy of Sciences, Committee on Science, Engineering and Public Policy. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington, DC: National Academy Press, 2007.
- Riedel, Brian M. "The Advanced Technology Program: Time to End this Corporate Welfare Handout," *Heritage Foundation Backgrounder* #1665, July 15, (2003). Available at <http://www.heritage.org/research/budget/bg1665.cfm>.
- Science Debate 2008 home page. <http://www.sciencedebate2008.com>.

- Singer, S. Fred. "The Great Global Warming Swindle," *San Francisco Examiner*, May 22 (2007), available online at <http://www.independent.org/newsroom/article.asp?id=1945>.
- Smith, Bruce L. *American Science Policy Since World War II*. Washington, DC: The Brookings Institution, 1990.
- U.S. Congress, House of Representatives, H.R. 1, "The American Recovery and Reinvestment Act of 2009," [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111\\_cong\\_bills&docid=f:h1enr.pdf](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h1enr.pdf).
- U.S. Congress, House of Representatives. [http://science.house.gov/legislation/leg\\_highlights\\_detail.aspx?NewsID=1938](http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1938).
- U.S. Department of Energy. "DOE Announces Nearly \$800 Million from Recovery Act for Biofuels." May 5 (2009). [http://apps1.eere.energy.gov/news/daily.cfm/hp\\_news\\_id=164](http://apps1.eere.energy.gov/news/daily.cfm/hp_news_id=164).
- \_\_\_\_\_. "Over \$467 Million in Funding Announced for Geothermal and Solar." May 27 (2009). [http://apps1.eere.energy.gov/news/daily.cfm/hp\\_news\\_id=167](http://apps1.eere.energy.gov/news/daily.cfm/hp_news_id=167).
- \_\_\_\_\_. "Recovery Act Awards for Electric Drive Vehicle Battery and Component Manufacturing Initiative." n.d. [http://www1.eere.energy.gov/recovery/pdfs/battery\\_awardee\\_list.pdf](http://www1.eere.energy.gov/recovery/pdfs/battery_awardee_list.pdf).
- \_\_\_\_\_. "State Energy Program." [http://apps1.eere.energy.gov/state\\_energy\\_program/](http://apps1.eere.energy.gov/state_energy_program/)
- \_\_\_\_\_. "Technology Focus: Single-Family Residential Building Weatherization." <http://www1.eere.energy.gov/femp/pdfs/WeatherizTF.pdf>.
- \_\_\_\_\_. "Transformational Energy Research Projects Win \$151 Million in Funding," press release, October 26, 2009. <http://arpa-e.energy.gov/public/PR-102609.pdf>.
- U. S. Department of Labor, Bureau of Labor Statistics. "Labor Force Statistics from the Current Population Survey." January 3, 2010. [http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series\\_id=LNS14000000](http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=LNS14000000).
- U.S. National Institute of Standards and Technology, Technology Innovation Program home page. <http://www.nist.gov/tip/>.
- U.S. President, The White House. "Executive Order: Removing Barriers To Responsible Scientific Research Involving Human Stem Cells," March 9 (2009). [http://www.whitehouse.gov/the\\_press\\_office/Removing-Barriers-to-Responsible-Scientific-Research-Involving-Human-Stem-cells/](http://www.whitehouse.gov/the_press_office/Removing-Barriers-to-Responsible-Scientific-Research-Involving-Human-Stem-cells/)
- \_\_\_\_\_. "Memorandum For The Heads Of Executive Departments And Agencies on Scientific Integrity," March 8 (2009). [http://www.whitehouse.gov/the\\_press\\_office/Memorandum-for-the-Heads-of-Executive-Departments-and-Agencies-3-9-09/](http://www.whitehouse.gov/the_press_office/Memorandum-for-the-Heads-of-Executive-Departments-and-Agencies-3-9-09/)
- \_\_\_\_\_. "President Barack Obama's Inaugural Address," January 21, 2009. <http://www.whitehouse.gov/blog/inaugural-address/>
- \_\_\_\_\_. "Remarks By The President On Innovation And Sustainable Growth," Hudson Valley Community College, Troy, New York, September 21 (2009). [http://www.whitehouse.gov/the\\_press\\_office/Remarks-by-the-President-on-Innovation-and-Sustainable-Growth-at-Hudson-Valley-Community-College/](http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-on-Innovation-and-Sustainable-Growth-at-Hudson-Valley-Community-College/).
- \_\_\_\_\_. "Remarks by the President Challenging Americans to Lead the Global Economy in Clean Energy," Massachusetts Institute of Technology, Boston, Massachusetts, October 23 (2009). <http://www.whitehouse.gov/the-press-office/remarks-president-challenging-americans-lead-global-economy-clean-energy>.
- \_\_\_\_\_. "Remarks of President Barack Obama at the National Academy of Sciences," April 27 (2009). <http://blogs.sciencemag.org/scienceinsider/2009/04/obama-at-the-ac-2.html>.