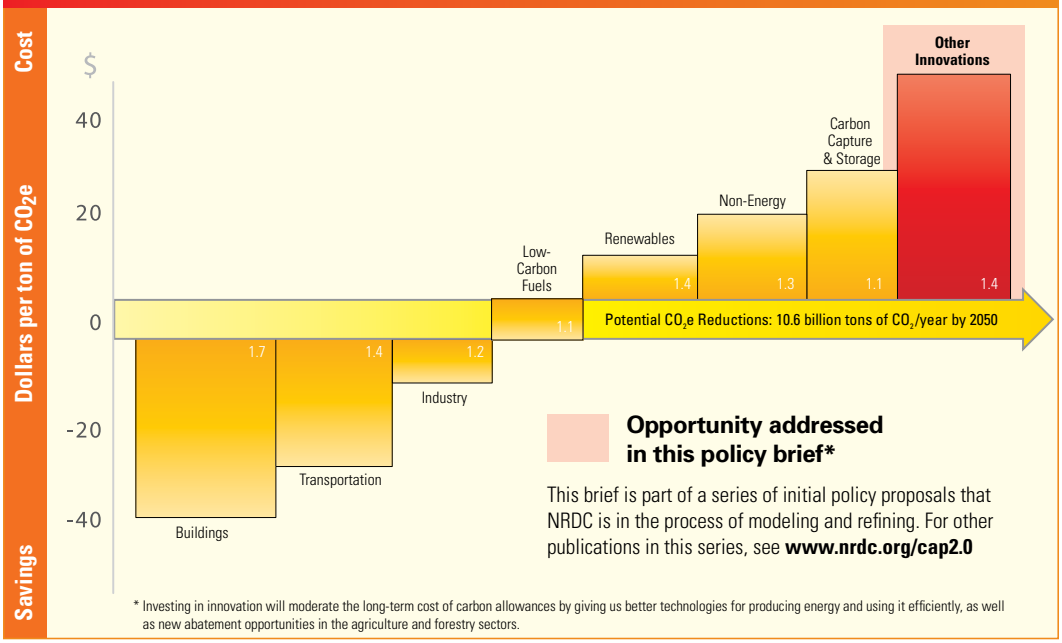
Part of a series on
CAP 2.0

Policy Brief

Innovative policy can help advance the next generation of clean technologies



Developing the Technology of the Future: Federal Climate Legislation Can Maximize Low-Carbon Technology Innovation

For more information, please contact
Cai Steger at
(212) 727-2700
www.nrdc.org/cap2.0

America needs strong federal action to contain the threat of global warming. But a series of barriers stand in the way of the technology innovation needed to develop a clean energy economy at the lowest possible long-term cost to society. Strategically increasing research, development, and demonstration (known as RD&D) funding for low-carbon technologies can help to overcome these barriers and jumpstart innovation.

Strong Federal Legislation Can Remove Barriers to Clean Energy Technology

The private sector tends to under-invest in new low-carbon technologies because of the risk of "innovation spillovers"—that other companies will benefit from their initial research investment. But public funding is currently insufficient to fill the gap between what companies invest and what is needed. In turn, this leads to several damaging outcomes:

- Inadequate investment in basic energy research, which is the primary source of next-generation clean technologies.
- Limited funding to demonstrate high-potential applied research and commercialize market-ready ideas.
- Acute shortfall in long-term, high-risk (high-reward) research in both the private and public sector.
- Limited coordination and insufficient joint investment between government, academia, and industry, making it difficult to transfer new energy technologies into the marketplace.
- Insufficient pipeline of new scientists and researchers trained to focus on low-carbon technologies.

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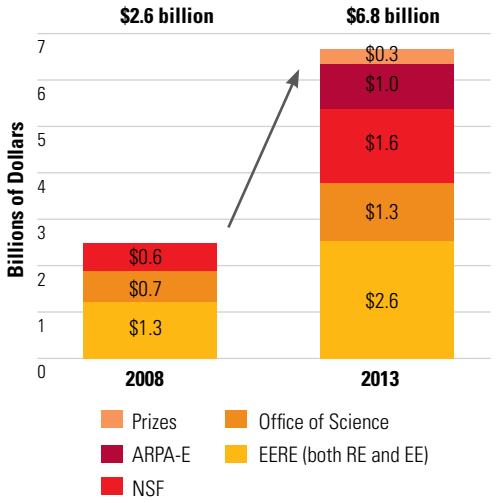
NRDC's strategy for federal climate legislation helps to overcome some of these challenges. Our recommendations include:

- *Significantly increase federal R&D funding.* Literature suggests that increased federal energy RD&D can yield substantial net economic benefits, especially if accompanied by improved prioritization, administration, and oversight.
- *Direct additional funding to programs that enable high-risk, long-term bets*, to take advantage of the dynamic and unpredictable nature of innovation.
- *Ensure the private sector plays a large role in innovation.* It should be given incentives to do so in part through strategies known as "demand pull" incentives, which help pull new technologies through the deployment cycle.[1]
- *Use multi-decade climate legislation to provide a stable funding stream*, which can ensure continuity and availability of RD&D funds, eliminating some of the volatility inherent in the appropriations process.

Figure 1: Proposed Funding Increase for Clean Energy RD&D ($2008 Billion)



An optimal federal energy RD&D strategy requires a balanced portfolio of investments that incorporate basic and applied research. In some cases, existing programs may simply require more funding, but new programs will also be required. (See Figure 1.)

NRDC's Roadmap for Increasing Clean Energy RD&D

STEP 1: Develop a sustained low-carbon technology strategy and roadmap

In order to launch an effective and strategic low-carbon RD&D strategy, the U.S. President's Council of Advisers on Science and Technology (PCAST), or equivalent advisory group, should create a detailed climate, renewable energy and efficiency RD&D roadmap with input from industry, government, and academia. Innovation funding guidelines for climate, efficiency, and renewable energy technologies should be informed by this roadmap.

STEP 2: Significantly increase Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) spending on renewable energy and energy efficiency

According to recent budget estimates, overall direct spending by the Department of Energy (DOE) on total energy RD&D is currently $3.5 billion. At 3 percent of total government RD&D spending, this represents a substantial decline from a high of 10 percent in the 1980s.[2] Moreover, more than three-fifths of the $3.5 billion is allocated for nuclear (fission and fusion) and fossil fuel energy, with renewable energy and energy efficiency each receiving about one-fifth, or a total of $1.3 billion through the Office of Energy Efficiency and Renewable Energy.

EERE focuses on applied research and demonstration of pre-commercial technologies, along with limited funding of very early deployment. Within EERE, we propose doubling spending on energy efficiency and renewable energy RD&D to $2.6 billion (in 2008 dollars) by 2013. This represents a manageable annual growth rate of just over 20 percent. This could be funded using revenue from carbon allowances, or by redirecting existing RD&D appropriations from fossil fuels and nuclear to renewable energy and energy efficiency.

STEP 3: Increase funding for the National Science Foundation (NSF) via a Climate and Low-carbon Technology Working Group

The NSF receives about $6 billion annually from the federal government, which it spreads across a variety of science and engineering fields on basic science projects, looking to encourage transformational and multi-disciplinary fundamental research. NSF is well-regarded and plays a vital role in backing basic research that receives little private investment, funding 20 percent of federally funded research at American universities and colleges. It also plays an important part in developing the next generation of scientists and researchers.

While it does not have a program specifically focused on energy research, energy projects can be funded across several categories, including Biological Sciences ($610 million FY08), Engineering ($525 million FY08), and Geosciences ($750 million FY08).[3] In addition, NSF also directs an Office of Polar Programs ($440 million in FY08) and a Climate Change Science Program (~$200 million FY08).[4]

We propose the creation of a new Climate and Renewable Technology Working Group housed within NSF that would manage an incremental $1 billion by 2013 (in real terms) directed competitively towards institutions and scientists that focus on climate and low-carbon technology research.

STEP 4: Increase targeted funding for the DOE Office of Science

The national laboratories represent one of the largest scientific research systems in the world. Development of or improvements in radar, the atom bomb, the Internet, climate models, and high-performance computing are a few of the innovations that have come from the national labs. In addition, the Office of Science contributes significant funding toward three cross-agency climate-change initiatives: the Climate Change Science Program ($128MM FY08), the Climate Change Research Initiative ($24MM FY08) and the Climate Change Technology Program ($498 MM FY08).[5]

Last year, slightly more than $4 billion was given to the DOE's Office of Science to conduct basic R&D on mostly non-renewable energy technologies and sciences. This funding is in turn almost exclusively allocated by the Office of Science to the national laboratories. It is challenging to target funding within the Office of Science toward low carbon technologies, efficiency and climate change, given the DOE's traditional focus on fossil and nuclear research. Overlapping scientific missions and budgets across different programs and the need to avoid micro-managing long-term basic research further complicate the picture.

We propose an increase in funding for the specific Office of Science climate-related programs referenced above within a multi-year framework, with an end goal of doubling funding (in real terms) for each climate program by 2013 ($1.3 billion in $2008).

STEP 5: Fund an Advanced Research Projects Agency for Energy (ARPA-E) with a climate-focused mandate and transparent priorities

Several innovation think tanks and various experts have recommended funding an Advanced Research Projects Agency for Energy (ARPA-E). This institution was previously authorized by act of Congress (America Competes Act in 2007) but never funded.

The ARPA-E model is based on the Defense Advanced Research Projects Agency (DARPA). DARPA is a small (220 employees), nonhierarchical organization with an annual budget of about $3 billion. It performs no R&D itself, but funds high-risk research through a flexible contracting model. It seeks to develop fluid, coordinated teams, while fostering consortia of industry, academics, and labs to work on critical defense-related research.[6] It has developed a number of industry-transforming technologies, including graphical user interface systems, GIS mapping systems, and radar.

ARPA-E has been similarly conceived as a small and nimble group, sponsoring transformational energy RD&D currently screened out by risk-averse institutes and labs. It will further bridge the gap between basic research (especially at universities) and industrial development, while possessing greater independence and isolation from pressure to deliver short-term results.

We propose that ARPA-E should be funded with $300 million at first, increasing to $1 billion over five to six years, after which its effectiveness can be evaluated. This echoes a proposal by the National Academy of Sciences regarding ARPA-E.[7] A working group will be established with scientists at ARPA-E and EERE to minimize potential duplication of effort.

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While there will be challenges with translating the DARPA approach to energy sector technologies and civilian commercial applications, we believe that the potential benefits justify testing the concept. Focused priorities with quantifiable objectives will help to ensure the success of ARPA-E.

STEP 6: Fund technology innovation prizes on a limited scale at first, with management housed in ARPA-E

Innovation "inducement prizes" can complement more conventional RD&D by focusing public attention on the clean energy challenge and reaching more diverse innovators. Inducement prizes have a long history, stretching back to maritime prizes offered in the 18th century by the British government. DARPA and NASA have recently experimented with prizes as well. Although, there is some evidence of success from past prize programs, it is too early to judge DARPA and NASA's initiative.

To test the innovation prize concept and reach new innovators, $250 million per year should be set aside to fund ten separate energy challenges, which will be established by the PCAST advisory board referenced under Step 1 above. These prizes should address high-priority objectives that can cause a step change in some aspect of low-carbon technologies, efficiency or climate science. Given its focus on high-risk, high-reward performance, ARPA-E should administer the technology innovation prizes.

Other Potential Supporting Measures

- *Expand RD&D tax credits for business*– Tax incentives can encourage the private sector and entrepreneurs to undertake additional innovation investment. Current tax incentives for RD&D are estimated to cost $5 billion annually, and these incentives induce matching private-sector R&D spending of roughly the same magnitude.[8] Expanded tax credits could increase RD&D spending with limited administrative burden, while avoiding technology micro-management or targeting of individual firms. Congress should consider expanding RD&D tax credits but we do not recommend using climate legislation for this purpose as it is difficult to restrict this form of tax credits to low-carbon technologies only.

- *Commit to energy and environmental education*– To enable clean energy innovation it is also important to support strong education in engineering, science, math, economics, and policy. This needs to start with K-12 and continue into undergraduate and graduate universities. It is also important to support professional continuing education, and internship programs that can train future energy and environmental professionals.

Now Is the Time to Invest in Our Technology Future

Moving to a clean energy economy based on renewable energy instead of dirty and outmoded fossil fuels will improve our economy, environment, and national security. Many of the technology solutions are already in place, but federal climate policy that includes incentives for innovative American companies will ensure that we are leaders in developing the next generation of low-carbon climate technologies.

[1] For more information on "demand-pull" strategies, see the NRDC fact sheet "Powering Up Renewable Energy: NRDC's Roadmap for Immediate and Effective Renewable Deployment," available online at nrdc.org/cap2.0.

[2] Gregory F. Nemet and Daniel M. Kammen. U.S. energy research and development: Declining investment, increasing need, and the feasibility of expansion. Energy Policy, January 2007

[3] Federal R&D Funding Down in FY 2007. NSF 08-303, February 2008. http://www.nsf.gov/statistics/infbrief/nsf08303/#tab4

[4] Presentation of FY 2009 Budget Request to Congress, Slide 22 of 42. http://www.nsf.gov/news/speeches/bement/08/alb_fy09budget/sld022.jsp

[5] Office of Science, Appropriation Summary by Program, FY 09. http://www.science.doe.gov/obp/FY_09_Budget/Overview.pdf

[6] Rising Above the Gathering Storm, National Academies, October 2005 http://www.nap.edu/catalog.php?record_id=11463#toc

[7] Climate Technology Research, Development, and Demonstration: Funding Sources, Institutions and Instruments. Richard Newell, RFF. http://www.rff.org/rff/Publications/upload/31818_1.pdf

[8] Ibid.