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Prepared for the
Senate Committee on Energy and Natural Resources
On
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and Infrastructure Credit Act of 2005

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Mr. Chairman: I am pleased to appear before this committee to offer comments on S. 388, the Climate Change Technology Deployment and Infrastructure Credit Act of 2005. There is growing acknowledgement that the threats posed by climate change are real and that some near-term actions beyond the administration's voluntary initiatives and ongoing technology programs are appropriate. The authors of S. 388 clearly understand this and are to be commended for advancing new initiatives to promote the adoption of greenhouse gas reducing technologies by U.S. industry.

I speak as an economist who has been involved in issues of climate change for almost two decades. I have had the privilege of serving in senior policy positions under prior Republican and Democratic administrations. Currently, I am a senior fellow at Resources for the Future (RFF), a 53-year-old research institution, headquartered here in Washington, D.C., that specializes in energy, environmental, and natural resource issues. RFF is avowedly independent and nonpartisan and shares the results of its economic and policy analyses with members of both parties, as well as with environmental and business advocates, academics, members of the press, and interested citizens. I emphasize that the views I present today are mine alone. RFF takes no institutional position on legislative, regulatory, judicial, or other public policy matters.

As a nation, we have extensive experience with government-aided technology development and adoption programs—some favorable and some not so favorable. Interestingly, in reviewing the experiences of the research-and-development oriented programs at the U.S. Department of Energy, a recent National Resource Council study found that only a few of these programs proved highly valuable, although the benefits of the successes justified the overall expenditures.¹ Rather than review that history in detail, I will draw on the now extensive economics literature that examines the role of technology incentives, such as those embodied in S. 388, to help in the long-term challenge of reducing emissions of greenhouse gases. To preview my conclusions, I paraphrase my RFF colleague, Carolyn Fischer, a recognized scholar in the field of

¹ National Research Council. 2001. *Energy Research at DOE Was it Worth It?* National Academy Press.

technology policy. As she notes, the ‘engine’ for reducing greenhouse gas emissions must involve a portfolio of policies. Technology policy, a critical element of that portfolio, can help the engine run faster and more efficiently. However, it only helps if the engine is already running.

But let me begin at the beginning. The consensus is that it would be prohibitively expensive to rely on currently available technologies to reach the substantial emission reductions needed over the long term to attain or even approach the goal of stabilizing atmospheric concentrations of greenhouse gases. Not surprisingly, the single largest source of variation in climate mitigation costs in large-scale, energy-economic models is the difference in assumptions about the rate of future technological progress. Clearly new technologies are needed, and it is widely recognized that government has an important role to play in spurring the development and diffusion of these technologies.

Without some kind of outside incentives, the private sector typically will underinvest in research, development, and demonstration because innovators cannot reap the full benefits to society of their advances. In unfettered markets, the existence of these “spillovers” reduces private incentive to pursue innovation, as others will mimic the innovation without compensating the inventors. While patents and similar means are used to protect investments in innovation, that protection is limited. A successful innovator typically captures substantial rewards, but those gains are sometimes only a small portion of the total benefits to society arising from the innovation. This rationale underlies government support for research, development, and demonstration programs, including the National Science Foundation, the national research laboratories, public universities, and others.

As clearly articulated in a recent paper by my RFF colleague Richard Newell and others, these environmental and knowledge externalities have long been at the center of debates

about technology policy.² More recently, we have come to understand some additional market failures that may operate in the adoption and diffusion of new technologies. For a variety of reasons, the cost or value of a new technology to one user may depend on how many other users have adopted the technology. Generally speaking, users will be better off the more other people use the same technology, as this increases what is known as “learning by doing” and “network externalities.” Typically, it takes time for potential users to learn of a new technology, try it, adapt it to their particular circumstances, and become convinced of its superiority. Consequently, the early adopter of a new technology creates a positive benefit for others by generating information about the existence, characteristics, and likely success of the new technology.

The lack of basic information about the true value of a new technology poses additional concerns. The developer of the technology is inherently in a better position to assess its potential than outsiders. In the absence of a clear and convincing demonstration of the benefits of the new technology, a firm attempting to raise capital will be greeted by skeptical investors who will demand a premium for what is perceived as a high-risk project.

The argument for public support is even stronger in the case of climate change technologies, where not only do inventors fail to capture all the gains to their investments, but also the gains themselves are not fully translated to the firms’ bottom line because there is no market value associated with emission reductions. Further, the prospect of future value—which is driven by policy outcomes—is highly uncertain. And, even if we were to adopt a market-based emission program, it is possible the market price of reductions will fall below the true climate benefits, again leaving climate innovations undervalued.

Absent government incentives, corporate concern for the environment may overcome some hurdles. Working against this kind of “corporate altruism,” however, is the need to

² Jaffee, Adam B., Richard G. Newell, and Robert N. Stavins. 2004. “A Tale of Two Market Failures: Technology and Environmental Policy,” RFF Discussion paper 04-38 (forthcoming in *Ecological Economics*).

compete in the marketplace. A company that puts meaningful effort into reducing greenhouse gas emission, rather than reducing costs, may eventually lose out to one that just seeks to reduce costs.

It is exactly this need to align public and private interests that underlies the argument for an emissions trading program, or similar mechanism, alongside technology development and demonstration programs. While the government seeks technologies to cut carbon, the private sector seeks technologies to cut costs. Market-based policies that put a value on emission reductions encourage firms to conserve, to reduce emissions from existing technologies, and to adopt new low-carbon or no-carbon technologies. However, policies that focus only on technology adoption fail to take advantage of reductions from existing technologies and conservation.

Market-based policies to reduce emissions have two distinct effects: they reduce emissions in the near term *and* they alter the incentives that firms have for developing and adopting new technologies for the future. Few would argue that it is the private sector, not the government, that has driven innovation and growth in modern economies. Industry, according to data from the National Science Foundation, funded 63 percent and performed 68 percent of all research and development in 2003 (the latest year data is available).³ Even as government tries to encourage greenhouse gas-reducing technologies, private efforts to improve greenhouse gas-increasing technologies will likely continue unless firms see some kind of value associated with emission reductions.

Technology programs, for example, may succeed in bringing down the cost of integrated gasification and combined cycle (IGCC) coal plants so that they eventually overtake conventional pulverized coal. According to the U.S. Energy Information Administration, IGCC is currently about 15 percent more expensive in fixed costs and slightly cheaper in variable costs. But, how can technology programs ever make capture and sequestration cheap enough so that firms will voluntarily capture and sequester emissions? The real choice is whether such controls are eventually required under a command-and-control

³ www.nsf.gov/sbe/srs/infbrief/nsf04307/start.htm

style regulation or whether a market-based system is used to flexibly encourage use of the cheapest option. Economic analysis has consistently shown that market-based programs are considerably cheaper than command-and-control alternatives. Analysis of the acid rain program, for example, suggests a savings of over 40 percent compared to command-and-control alternatives. Market-based programs have the additional advantage of continually encouraging innovation in a direction that minimizes costs and reduces emissions.

In other arenas, the potential for technology programs to succeed on their own is even less clear. Progress toward a fuel-cell car, for example, must compete with improvements in conventional engines, hybrid technology, and clean diesel. While technology programs clearly have a role, sending a signal about the value of emission reductions will go a long way towards allowing the various technologies to compete on a level playing field.

In all of this discussion about technology, and the need to encourage long-term solutions, one point that is lost is the opportunity for relatively inexpensive emission reductions right now. Such emission reductions using more conventional technologies may not provide a complete solution to the climate problem, but by delaying the accumulation of greenhouse gases in the atmosphere, they buy time for the long-term solutions. Even if a major technology breakthrough is needed to reach climate stabilization goals, there are many smaller and medium-sized innovations—the type typically associated with learning by doing—that can yield significant benefits. Sending a signal about the value of emission reductions provides the right information to the private sector about the importance of undertaking those activities.

Although technology policies can be seen as first step in a long process, implementation of technology policies without the concurrent adoption of some type of emissions policy is unlikely to achieve major reductions in emissions, even over the long term. Further, the absence of an emissions policy removes a potential source of ongoing funding to support the technology policy, for example, through sale of some portion of emission allowances. In difficult fiscal times like these, the value of such funding is particularly high. Of

course, technology policies are often popular with the general public. Many of the benefits of such policies may accrue to a focused group of constituents, while the costs are dispersed. This makes technology policy an attractive option from a political economy perspective.

Clearly, the long-term goal is to harness the ingenuity of the private sector to develop and adopt greenhouse gas reducing technologies without the government constantly having to decide which ones to support. Most logically, government can weigh in when it sees a particular opportunity, perhaps along the lines of IGCC, but it is not reasonable to expect government to see all options, now and in the future, or to always pick the right ones. That's a role to which the private sector is far better suited.

Consistent with the basic logic laid out here, the recent report by the National Commission on Energy Policy, as well as a paper I co-authored with several of my RFF colleagues (appended to this testimony), tries to link the technology development and the mitigation sides of the problem into a coherent policy framework. Although there are a number of important differences between the Commission's proposals and ours, they both couple significant technology incentives with an emissions trading program. Both proposals include a safety valve to assure that the program will not exceed expected costs. Both proposals suggest selling a small portion of permits to fund critical technology activities. Finally, both proposals recommend that further U.S. action be linked to comparable action by major emitters and trading partners.

Like most fields of endeavor, the economics profession is not completely united on how best to stimulate technology development to address the problem of climate change. While not attempting to review all competing approaches, I would mention one particular line of thought in circulation these days that is somewhat at odds with the ideas laid out here. Specifically, it is argued that because climate change is such a long-term problem, it is not appropriate to encourage emissions reductions now. Rather, it is argued, the policy focus should be entirely oriented to technology development. Although there are various issues here, the single point I would make is that even this view supports near-term

emissions reductions as long as the cost is no higher than the expected value of future mitigation benefits. While one can debate the true magnitude of these benefits, the literature would certainly support an emissions price as proposed by both the National Commission on Energy Policy and in our paper.

In closing, I thank you for the opportunity to appear before this committee. As an economist, I applaud the expansion of incentives for adoption of greenhouse gas reducing technologies contained in S. 388. To the extent that such incentives can accelerate the diffusion of information about the characteristics and benefits of those technologies to the community of potential users and investors, the public can clearly gain. At the same time, the inherent limitation of this approach must be recognized. Certainly many previous efforts at technology demonstration and commercialization are widely perceived to have missed the mark. Notwithstanding the previous efforts—and the potential for improved performance by new program designs—technology approaches alone are unlikely to successfully address the threat posed by climate change.