TECHNOLOGY POLICIES FOR REDUCING GREENHOUSE GAS EMISSIONS

MEETING SUMMARY:

Workshop on Technology Policies for Controlling Greenhouse Gas Emissions
The Heinz Center, November 30, 1998

A RESEARCH PROJECT OF

THE H. JOHN HEINZ III CENTER FOR SCIENCE, ECONOMICS AND THE ENVIRONMENT

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Technology Policies for Reducing Greenhouse Gas Emissions

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The Heinz Center greatly appreciates the valuable contributions and thoughtful critiques provided by the workshop participants. The participants do not, however, necessarily approve, disapprove, or endorse this report. The Heinz Center assumes full responsibility for the report and the accuracy of the contents.

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Overview:

A well-crafted technology policy can help accelerate the development and adoption of new technologies for lowering emissions of greenhouse gases (GHGs). But the design task is not simple. GHG sources are widely dispersed through the economy and involve hundreds of technologies. The goal of this workshop—and the larger project of which it is part—was to begin to develop a more systematic approach to policy design to help decisionmakers more successfully link potential policy levers with emissions sources. Such an approach might also encourage decisionmakers to look more closely at technology policies that have not been part of the current debate, which has centered on funding levels for existing R&D and deployment programs of the Department of Energy (DOE) and other agencies.

About a dozen industry and university experts met at the Heinz Center offices in Washington on November 30, 1998 to explore this issue. (See inside title page for a list of participants.) Participants first heard several background presentations (see attachment 1 for the agenda) and then separately discussed three groupings of technology policies:

- Direct funding of research and development (R&D) and design and development (D&D), e.g., funding university research.
- Policies that induce private R&D or subsidize production, directly or indirectly, e.g., R&D tax credits and government procurement.
- Diffusional policies that foster deployment through information and learning, e.g., technology and industrial extension services

The workshop discussions considered only those policy approaches that are both *voluntary* for industry or consumers and require some *governmental funding* or other action. The workshop did *not* consider mandatory environmental policies such as regulatory limits, emissions trading, or carbon taxes.

Key questions posed to the participants for each policy included: Have you or your firm experienced past successes or failures? Under what conditions and for what technologies might your firm participate in, or encourage, these types of government programs in the future? Finally, in your opinion, what types of technologies and in what situations are these instruments likely to work or not work? (See attachment 2 for a brief overview of the goals of the project and meeting.)

Prior to the meeting, participants had been sent a summary of *Technology Policies for Controlling Greenhouse Gas Emissions: A Taxonomy*, a paper prepared for The Heinz Center, used as background material for the meeting.

Workshop Conclusions

While new and more cost-effective technologies may be key to lowering emissions of greenhouse gases, participants had modest expectations for government technology policy to substantially spur their development or diffusion, absent clear regulatory requirements or price signals. There was, however, one notable exception: federally funded research, in particular, grants to universities. Other promising policy tools, when used appropriately, include: R&D contracts to industry consortia; government procurement; education and training of engineers, scientists, and technicians; and publicity (as illustrated by the Baldrige award for quality practices); and consumer information.

Of the 14 policy approaches discussed, the one thought to affect corporate planning the least was R&D tax credits. Though participants were uncertain whether R&D tax credits affected the overall level of corporate research, they were quite confident that such tax credits did not influence research objectives. Other tools that seemed inappropriate or ineffective for lowering GHG emissions included large scale demonstration programs and R&D contracts with single private firms.

Modest expectations for technology policies stemmed in part from two often interrelated factors. Past technology policy successes seem to correlate with 1) the perceived depth of political support for a clear, common mission and 2) the consistency and duration of policies. Energy technology policies have not enjoyed the same depth of support as, for example, those for military technology development or to advance the biomedical sciences and technologies related to health care. Similarly, initiatives to spur the development of energy technologies have typically had lifetimes of a few years as opposed to the decades of consistent attention to the cold war or advances in medical technology. Participants stressed that industry is motivated best when goals are clear, consistent through time, and given adequate support and lead time to achieve.

The analytic structure originally proposed by the Heinz Center for helping decision makers match policies to specific problems was felt to be of some, but limited, utility. In that view, government could help bring technologies into the marketplace by helping to lower either or both technical risk and business risk. Fostering 1) the *creation* of knowledge and 2) the *application* of knowledge can help to lower technical risk faced by firms. Business risk can be lowered through 3) financing (tax credits or other subsidies) and through 4) provision of information.

As mentioned above, the participants pointed to the extremely important role for government in helping create new knowledge. Again, the single most effective approach was considered to be university research, but careful attention should be paid to other approaches, too. Given market pressures and depending on the industry, corporate research with payoffs beyond a year or two can be squeezed out by shorter term investments. Government procurement has sometimes been a major force in inducing the creation of new knowledge and fostering applications through product development and early commercialization. Participants did warn, however, that federal procurement mechanisms can be so cumbersome as to outweigh the benefits of participation by firms that do not regularly pursue government contracts.

Reducing business risk was generally perceived as the more difficult challenge. Participants were skeptical about the benefits of such finance mechanisms as tax credits for producers or purchasers of new technologies, again, at least over the too-short time they typically remain in place. Government incentives make sense, in their opinion, only if it appears likely that the technology will be able to make it in the marketplace on its own after the subsidy program expires.

They pointed to several instances where information programs had been effective, but several participants thought that for the greenhouse gas problem, provision of information might more appropriately be an adjunct to other policies.

The participants felt strongly that a diverse portfolio of approaches would be needed to have significant impact. They emphasized the differing needs of various industries. Though tools to foster knowledge creation were judged the most important levers available to government, a successful policy portfolio should incorporate other goals and approaches, too.

Again, the structure proposed by The Heinz Center was judged to be an incomplete, but helpful, framework for creating a portfolio of policies to meet specific technology challenges. The participants suggested that if government were truly serious about matching a portfolio of technology policies to specific sectors and technology challenges, it should undertake a planning process similar to that begun under the DOE "Industries of the Future" program to develop a research agenda. Detailed "roadmaps" to help foster not only knowledge creation but to also address the challenges of commercialization and eventual diffusion were needed sector-by-sector. The participants felt that there were many factors unique to each sector—for example, the willingness of firms to work together and the significance of intellectual property protection—that made generalizations about the effectiveness of various policies of limited utility.

Summaries of the Morning's Presentations

Presentation by David Gardiner

Mr. Gardiner, Assistant Administrator for Policy, Environmental Protection Agency, covered two topics: 1) a review of the recent Conference of the Parties to the Framework Convention on Climate Change in Buenos Aires and 2) a discussion of the Administration's Climate Change Action Plan (CCAP).

Mr. Gardiner noted two major accomplishments of the Buenos Aires meeting. First, developing countries for the first time expressed willingness to undertake emissions reductions. For example, the host country Argentina stated that they would be willing to voluntarily cap emissions. Second, the Parties agreed to a work plan to complete the needed details for the Kyoto Protocol's flexibility mechanisms within two years.

Gardiner presented an overview of the Administration's CCTI, whose goals are to develop new technologies and to diffuse both existing and new technologies, once developed. The five-year proposal was for a $2.7 billion increase in R&D and a $3.6 billion for tax incentives, for example, for purchasers of energy-efficient building equipment, cars, and combined heat and power systems for industry. The first year request to Congress for increased R&D was $473 million; a $202 million increase passed. This amounts to between a 20 and 25 percent increase in spending for energy R&D. None of the $421 million first-year request for tax credits passed.

Presentation by John Holdren

Dr. Holdren's remarks primarily focused on Federal energy research and development, the major component of energy-related technology policy. Much of his presentation was based on a recent report by a panel he chaired for the President's Committee of Advisors on Science and Technology, "Federal Energy Research and Development for the Challenges of the Twenty-First Century." One of the findings of that report: "U.S. Federal R&D declined 3.4 fold between FY1978 and FY1997 if basic energy sciences as well as applied energy-technology R&D are included and 4.8-fold for the applied R&D alone." The report recommends a $1 billion increase, over a five year period, in the Department of Energy's budget for applied energy-technology R&D.

Also of particular relevance to the day's discussion was a presentation of "rationales for government involvement in energy R&D, demonstration, and deployment." Each of the many policy instruments that were the subject of the meeting address one or several of the following rationales.

According to Holdren, private actors don't do as much as *their* interests warrant due to:

- lack of information,
- lack of financing,
- lack of confidence,
- bureaucratic barriers, and

- perverse incentives.

Private actors don't do as much as *society's* interests warrant due to:
- externalities, that is, actions that negatively affect society as a whole, but not the private actors directly;
- public goods, that is, actions that private actors have difficulty profiting from, but that benefit society as whole;
- other non-appropriability of benefits; and
- high discount rates and risk aversion.

Presentation by John Alic and Bob Friedman: The Taxonomy in Brief

Table 1 groups 14 policy instruments into three categories:

1) direct funding for R&D.
2) policies that induce private R&D (e.g., through procurement) or subsidize production, directly or indirectly; and
3) diffusional policies that foster deployment through information and learning.

The first of these categories is the cleanest: it includes all forms of public spending for creation of new technical knowledge. The third category is also relatively well defined: policies 10-14, in one way or another, foster the application of knowledge. The middle group, policies 5-9, is less neat. It includes a variety of measures that support generation of new technology (and perhaps diffusion too) through means other than direct funding of R&D.

These policy tools can be compared and contrasted in many ways. Two important dimensions are the "targeting" potential of a policy - its usefulness in promoting specific technologies (amorphous photovoltaic cells, say) - and the extent to which a given policy functions through "technology push" as opposed to "market pull." For example, it is easy to target specific technologies through direct R&D support.

The technology push vs. market pull dimension is a bit more complicated, perhaps best approached in terms of decisionmaking by private firms. Firms considering technology investments must make judgments concerning two kinds of risk or uncertainty, technical and business. Technical risk refers to the possibility that target values for critical performance parameters (including costs) may not be achieved. Business risks stem primarily from uncertainties concerning revenue streams. If a new product fails to sell in the quantities expected, the firm may not recoup its expenditures even if the product is a resounding technological success.

Table 1: Technology Policies for GHG Reduction by Function/Impact

	Reduction in Technical Risk (Technology Push)		*Reduction in Business Risk (Market Pull)*	
Policy Category	*Knowledge Creation (R&D)*	*Knowledge Application (Development & Commercialization)*	*Through Financing*	*Through Information*
Direct Funding of R&D				
1. R&D contracts with private firms	√	√	Minor	
2. R&D contracts and grants with universities	√			
3. Intramural R&D conducted in government laboratories	√			
4. R&D contracts with consortia that include two or more of the actors above	√	Possible if private firms participate.	Minor	
Indirect Support for R&D and Technology Development; Direct or Indirect Support for Commercialization and Production				
5. R&D tax credits	Modest impacts possible.			
6. Tax credits or production subsidies for firms bringing new technologies to market		√	√	
7. Tax credits or rebates for purchasers of new technologies			√	
8. Government procurement		√	√	
9. Demonstration projects	√	√	√	√
Information and Learning				
10. Education and training		√		√
11. Codification and diffusion of technical knowledge		√		√
12. Technical standards-setting		√		√
13. Technology/industrial extension		√		√
14. Publicity, persuasion, consumer information				√

Note: The absence of a check mark in this table does not imply the absence of impact, simply that impacts will usually be less than for checked entries.

Summaries of Workshop Sessions

Session 1: *Direct Funding of R&D/D&D*

Four instruments were discussed:
1. R&D contracts with private firms (fully-funded or cost-shared)
2. R&D contracts and grants with universities
3. Intramural R&D conducted in government laboratories
4. R&D contracts with consortia that include two or more of the actors above

The group expressed clear and enthusiastic support for federal funding of university research (category 2). The primary reason: in most of the industries represented, corporate R&D is often forced to accept 6- to 18-month time horizons. University research can look farther into the future, providing results that become a basis for further work by corporations. Some industries have particularly benefited from this approach, for example, chemicals and biotechnology.

The participants pointed out that R&D contracts with private firms (category 1) had been particularly successful within the defense industries, but here the Department of Defense was both the funder and customer. Government is not the primary customer for energy technologies and thus participants were less supportive of this approach for greenhouse gases. In addition, several pointed to the paperwork burdens associated with acceptance of government funding. For example, one participant reported that his firm was unwilling to accept more than $10 million annual funding, the level at which government acquisition regulations covering "major" projects begin to apply. Nevertheless, for some types of research, for example, advanced energy systems, contracting with private firms is an appropriate and effective approach.

Much of the discussion centered around research consortia involving multiple firms (category 4 listed above.) Conclusions within this category were considerably more situation- and sector-specific than for the other three. As technology becomes more and more complex, the ability for a single firm, university group, or national laboratory to undertake large-scale projects diminishes. Firms are compelled—in some situations unwillingly—to partner in order to achieve their technology goals. Several examples of research consortia from the electronics and automotive industries were pointed to as clear successes.

Research consortia are less attractive, however, as the agenda moves from pre-competitive or generic technologies closer to the marketplace or if intellectual property concerns discourage firms from working together. Consortia become more attractive to industries that view themselves as competing with other sectors rather than among themselves.

Though as mentioned above, R&D contracts with single private firms were not judged to be particularly promising, government funding was considered a vital component of many

types of research by consortia. Multi-firm consortia can succeed without government funding within some industries and for some types of problems, but such funding is particularly important for research with long time horizons. The participants pointed out, however, that joint research works best when the goals and mission are defined by the industry partners, rather than by government. Sematech, in electronics, was put forward as a case in which the government was content to oversee expenditures of taxpayer dollars without micromanaging the R&D agenda. Modest government cofunding of projects primarily sponsored by the Electric Power Research Institute, another industry consortium, was also considered a cost-effective use of limited government funds. Participants in the workshop also expressed positive views of the ongoing "Partnership for a New Generation of Vehicles."

Research and development in government laboratories (category 3) was not held in particularly high regard. The CRADA (Cooperative Research and Development Agreement) mechanism was not considered a success by the industries represented at the workshop, in part because structuring the agreements is perceived as complicated and time-consuming. One participant characterized CRADAs as "answers looking for questions."

Session 2: ***Indirect Support for R&D/D&D; Direct or Indirect Support for Commercialization and Production***

Five instruments were discussed in the second session:

5. R&D tax credits
6. Tax credits or production subsidies for firms bringing new technologies to market
7. Tax credits or rebates for purchasers of new technologies (e.g., negative gas guzzler taxes on new motor vehicles)
8. Government procurement (e.g., of energy-efficient buildings)
9. Demonstration projects

Within this grouping, government procurement (category 8) was the instrument judged most promising for bringing lower emitting, less costly GHG technologies to market. However, the participants suggested that its effectiveness may be limited to the early stages of an industry and to smaller firms. They stated that government procurement regulations are so specialized and complex that firms are often unwilling to respond except for small procurements, for which the rules are simpler, or unless they have experience in dealing with big contracts. Nevertheless, the group concluded that almost "any product the government wants, it will get," though not necessarily at a price attractive to other buyers.

The effectiveness of procurement for bringing new technologies to market has certainly been demonstrated in defense. Participants felt that this was due not only to the dollar magnitude of these programs, but the fact that national security had been a consistent and lasting mission over many years.

Program consistency and timing are major factors when considering the likely success of other instruments in this grouping as well. The participants had mixed views of tax credits and other subsidies for producers (category 6) and tax credits and rebates to consumers (category 7). The group was skeptical about the prospects of programs that remain in place for only a few years, as has most often been the case for energy technologies. Though subsidies have spurred sales while in place, once withdrawn, the effects diminish quickly or vanish. Lacking assurance of long-term support, such programs are best suited to cases of rapid technical change.

If political support can be maintained, government still faces the question of whether to offer the subsidies to manufacturers or consumers. Participants felt that except in those instances where the manufacturer's first costs are high, consumers would likely be the preferred target. Even then, the appearance of subsidizing firms, or of favoring some firms over others, may limit political feasibility.

Even though fraught with difficulties, some participants felt that tax rebates or similar subsidies, if maintained for a decade rather than a few years, are the only feasible way to bring certain types of technologies into the marketplace. In this category are technologies that appear likely to drop in price given increased demand, but are unlikely to capture the interest of consumers until the price does drop. Fuel cells and similar high-efficiency technologies were offered as examples.

Demonstration projects (category 9) were thought to be an approach that no longer fit political realities. While some demonstration projects have been effective, they were generally not perceived as a cost-effective way to achieve technology goals. However, several of the group felt that some past failures were not really demonstration projects, but rather were expensive, large-scale experiments. These technologies should have been tested at a pilot scale before proceeding. Others pointed out that some of these projects did not lead to successful outcomes because they were undertaken with the expectation of higher energy costs, which did not emerge. True demonstration projects might still be helpful in circumstances where a large-scale prototype is needed to create or verify demand or where complex system problems need to be resolved.

The participants considered R&D tax credits (category 5) to be the least effective of the 14 instruments discussed. None of those present could think of a situation where the presence of the tax credit altered the composition of their research portfolio. However, all were willing to and did utilize tax credits when government made them available. Participants thought it possible that the tax credit might increase the total dollar amount devoted to research, but were not certain that this was in fact the case.

Session 3: ***Information and Learning***

Five remaining instruments were discussed during the last session of the day:

10. Education and training (technicians, engineers, and scientists; business decisionmakers; consumers)
11. Codification and diffusion of technical knowledge (e.g., screening, interpretation, and validation of R&D results, support for databases)
12. Technical standards-setting (e.g., for recharging electric vehicle batteries)
13. Technology and/or industrial extension services
14. Publicity, persuasion, consumer information (including awards, media campaigns, etc.)

Education and training of scientists, engineers, and technicians (category 10) was considered the most important of the governmental expenditures within this group. Similar to university-based research (category 1), this instrument returns its rewards for many years into the future. The group was less optimistic about the effectiveness of education and training for small business decisionmakers.

Most participants were also quite supportive of consumer information programs and award programs (category 14). Disclosure of information under the Toxics Release Inventory was considered quite effective; disclosure of GHG emissions may not have the same impact as for toxic chemicals but still might have some effect. Programs such as the Malcom Baldrige quality awards were also thought to have significant impacts on firm behavior.

The approaches in this last category were thought to be most effective in combination with others, rather than as stand-alone programs. Several participants expressed the belief that if, for example, some of the earlier programs that provided tax credits or rebates for purchasers of energy-efficient technologies had been combined with a consumer information program, the overall effort would have been much more successful.

For technical standard setting (as opposed to regulatory standard setting), the view of most of the participants was that government's role was to watch and make certain that industry was doing its job, but that the standard setting itself should be left to industry. Some concern was expressed over the effectiveness of U.S. participation in international standards-setting activities. The meeting participants had little experience with either technology extension programs (category 13) or codification and diffusion of technical knowledge (category 11) and thus could not comment on when these types of programs would be most effective.

Attachment 1: Agenda

Workshop on Technology Policies for Controlling Greenhouse Gas Emissions
November 30, 1998

9:00 - 9:20 a.m.	**Welcome and Introductions—***Rick Kelson, Vice President, Alcoa, Workshop Chair*
9:20 - 9:30 a.m.	**The Heinz Center—***Bill Merrell, President, The Heinz Center*
9:30 - 9:50 a.m.	**EPA's interest in technology policy; Review of the Administration's Climate Change Technology Initiative—***David Gardiner, Assistant Administrator for Policy, U.S. Environmental Protection Agency*
9:50 - 10:15 a.m.	**Technical opportunities for lowering emissions; The current climate change "technology policy" portfolio—***John Holdren, Director, Program in Science, Technology, and Public Policy, John F. Kennedy School of Government, Harvard University*
10:15 - 10:30 a.m.	**The Taxonomy—***The Heinz Center*
10:30 - 10:45 a.m.	*Break*
10:45 - 12:15 p.m.	**Direct funding for R&D** • Past successes and failures • Under what conditions and for what technologies might your firm participate in, or encourage, these types of government programs? • Types of technologies/situations where these instruments are likely to work and not work
12:15 - 12:45 p.m.	*Working Lunch*
12:45 - 2:15 p.m.	**Policies that induce private R&D or subsidize production, directly or indirectly** • Past successes and failures • Under what conditions and for what technologies might your firm participate in, or encourage, these types of government programs? • Types of technologies/situations where these instruments are likely to work and not work
2:15 - 3:45 p.m.	**Diffusional policies that foster deployment through information and learning** • Past successes and failures • Under what conditions and for what technologies might your firm participate in, or encourage, these types of government programs? • Types of technologies/situations where these instruments are likely to work and not work
3:45 - 4:15 p.m.	**Summary—***Rick Kelson, Alcoa*
4:15 p.m.	*Adjourn*

Attachment 2: Project Overview

Technology Policies for Controlling Greenhouse Gas Emissions

A Project of
The H. John Heinz III Center for Science, Economics and the Environment

The Heinz Center is examining technology policies to accelerate the development and adoption of technologies with lower emissions of greenhouse gases. This preliminary investigation proposes a taxonomy for evaluating a wide range of possible policy instruments. Such a perspective may be particularly useful to government and industry decision makers given the sheer number of energy-efficient and low-emission technologies, their rapid evolution, and their wide dispersion throughout the economy.

The project has two components. First, a discussion paper was developed that 1) examines the general relationship between government policy and technological innovation and 2) develops a taxonomy of instruments available to policy makers. For the purposes of this project, technology policy covers the gamut from direct government funding of R&D, to tax credits and technical assistance. It does not include broader environmental policies such as regulatory limits, emissions trading, or taxes per se. The discussion paper will consider only those policy approaches that are *both* voluntary for industry or consumers and that require some governmental funding or other action.

Second, in an informal workshop setting, we sought feedback from industry and policy scholars on the various policy approaches to gain a better understanding of their limits and potential. Key questions included: Which policies, from your experience, work better than others? In what circumstances have they worked best and what are major obstacles? Do some instruments seem most appropriate for particular economic sectors or industries? Are there special considerations for different types of greenhouse gas control technologies, for example, energy-efficient vs. low-emission vs. carbon sequestering technologies? Are there important considerations regarding relative roles of the private and public sector in developing and disseminating such technologies?

About a dozen industry and university experts met at the Heinz Center offices in Washington in November, 1998 to explore these and other pertinent issues raised in the white paper. The discussion was used to refine and modify the taxonomy of policy instruments presented in the paper. We hope the results of this preliminary investigation will be helpful to policy staff in EPA and other governmental agencies, as well as stimulate further examination of the potential of these policies to help lower greenhouse gas emissions. The project is being overseen by The Heinz Center's Global Change Steering Committee, composed of leaders from industry, government, academia, and the environmental community.