GHG Reduction Summit
Public Policy Primer[1]

Government policies are critical to the development and adoption of a portfolio of new technologies needed to abate global climate change.

However, technological change on an economy-wide scale will not happen overnight. Well-crafted public policies in both the short and long term will be instrumental in encouraging more rapid discovery, development, and deployment of climate change mitigation technologies, and will be essential complements to environmental policies that set limits on GHG emissions. Implementing these policies in the near term is essential for creating an environment in which technological innovation can thrive and contribute to GHG reductions.

Technology and Innovation Policies

Technological change is a complex process with multiple stages and feedbacks. These stages include "invention" and "innovation," which are distinct activities. Invention refers to the process of discovery that leads to scientific or technological advance, perhaps in the form of a demonstration or prototype. Innovation refers to the translation of the invention into a commercial product or process. Adoption or diffusion occurs when these inventions or innovations are actually used.

Although many types of policies affect invention and innovation, different policies influence outcomes at different stages of technology development. Technology policy tools can be grouped into three broad categories:

- Direct government funding for R&D;
- Policies that directly or indirectly support commercialization and adoption, or indirectly support development (e.g., R&D tax credits, patent protection).
- Policies that foster technology diffusion through information and learning (e.g., education and training, technical standard setting).

Selecting and applying the right policy or policies requires an in-depth understanding of where the "bottlenecks" are in the technology development process.

Regulatory Policy and Technological Innovation

In addition to technology policies, environmental and other regulatory policies will be required to stabilize atmospheric GHG concentrations. Environmental policies respond to market failures that leave economic actors with little incentive to reduce activities that have adverse effects on society as a whole, such as releasing harmful substances into the atmosphere or water. Well designed environmental regulations can significantly enable innovation, and the overall timing and stringency of regulations can determine the extent to which innovation occurs or is used. Moreover, environmental policies must provide certainty—that is, they must reassure investors that additional future regulations will not impair the value of near-term investments made to comply with the original environmental policy. To foster the greatest innovation, environmental regulations should be designed to provide incentives to firms to both prevent and reduce GHG emissions.

---

[1] Summarized from Pew Center on Global Climate Change, *U.S Technology and Innovation Policies to Address Climate Change*, http://www.pewclimate.org/docUploads/PEW_In-Brief_7.pdf

Regulations can be designed to assist innovation by promoting the greatest breadth of pollution reduction alternatives at the lowest possible cost. Many past environmental policies have relied heavily on "command-and-control" regulations that compel polluters to reduce their emissions to specified levels. Greenhouse gas emissions, however, are more suitably controlled through market-based approaches—such as emissions fees, pollution charges, or emissions cap-and-trade programs—because GHGs are emitted across all economic sectors around the world, and mix uniformly in the atmosphere.

The more recent turn toward "market-based" approaches for addressing climate change has created better incentives for continuous pollution reduction and technological innovation by giving firms greater flexibility and permitting compliance with regulations at lower cost.

Patterns of capital investment by businesses also can have a major impact on the success and cost-effectiveness of climate change policies. Capital stock, such as electricity generation plants, factories, and transportation infrastructure, is expensive and firms are often reluctant to retire old facilities and equipment. Certain policies can stimulate more rapid turnover of existing capital stock. These include putting in place early and consistent incentives that would assist in the retirement of old, inefficient capital stock; making certain that policies do not discourage capital retirement; and pursuing policies that shape long-term patterns of capital investment. In addition, even a modest carbon price could stimulate investment in new capital equipment. Likewise, uncertainty is likely to impede investment in new capital stock until the rules with respect to climate policy and other future environmental regulations are clarified.

Policy Guidance for Climate-Related Technology and Innovation Policies

Greenhouse gas emission reductions require a broad portfolio of policies to foster technology innovation and adoption by stakeholders ranging from multinational corporations to households. The policy portfolio should combine technology policies with other policies to induce innovation and deployment. Climate change policy response must account for uncertainties in the pace and cost of innovation. Technological evolution is always accompanied by unknowns concerning the levels of performance that can ultimately be achieved, the technological attributes that will prove most attractive to adopters, and the costs of these technologies. Technical design and development are fluid, open-ended activities with multiple choices and trade-offs and often-ambiguous selection criteria.

Uncertainties can be resolved only through learning processes. These processes can be slow and piecemeal, studded with lessons from both successes and failures. Technology-oriented policies and non-technology policies alike must function in such settings. Additional lessons for climate change policy include the following:

- Because the benefits of technological innovation come only with widespread adoption, and because adoption and learning are mutually reinforcing processes, the policy portfolio should support diffusion of knowledge and deployment of new technologies as well as research and discovery. In short, R&D alone is not enough. Because private investments respond primarily to near-term market incentives, public investments are necessary to build a technological infrastructure able to support innovation over the long term. A key ingredient of such infrastructure is a vibrant community of technologists and entrepreneurs working in settings in which knowledge and information flow freely. Government financial support for education and training, as well as for research, enhances such infrastructure. Intellectual property rights are important, but excessively strong intellectual property regulations may weaken such infrastructure.

- Competition among firms contributes to effective selection of innovations, and competition among academic research groups contributes to discovery. Similarly, competition among government agencies and government laboratories contributes to policy success. Competition exposes ineffectual bureaucracies, out-of-touch government laboratories, poor policy choices, and project-level mistakes. It encourages diversity by opening alternatives for exploration by technology creators and technology users alike. For these reasons, new funds for R&D should be channelled through multiple agencies and allocate funds to industry and other researchers on a competitive basis.
- Because there can be no learning without some failures, policy-makers cannot expect every investment to pay off. They must be prepared to tolerate mistakes, and to learn from them, just as entrepreneurs in the private sector do. In addition, policy-makers must be willing to accept a balanced portfolio that provides sufficient and sustained funding for both short- and long-term R&D. This means avoiding the temptation to pick "winners and losers" too early in the development phase of new technologies. Nonetheless, tolerance for error is no excuse for sloppy management or ill-conceived policies and programs.

Conclusions

Much technological innovation will be needed to mitigate global climate change. The most effective way to bring about these innovations is through a combination of technology policy incentives that accelerate the deployment of climate-friendly technologies and help create new markets for these products and processes, and environmental policies that set limits on GHG emissions. Implementing these policies in the near term is imperative. A well-balanced portfolio of government policies that stimulates innovation, incentivizes adoption, and avoids picking winners is the best path forward to meet the challenges of global climate change.

Additional Reading Material

In addition to the article upon which this primer is based, please review the following material:

- Clean Air Task Force:
    - *Four Policy Principles for Energy Innovation & Climate Change*: A Synthesis, June 2010, http://www.catf.us/resources/publications/files/Synthesis.pdf
    - *Innovation Policy for Climate Change*, September 2009, http://www.catf.us/resources/publications/files/Innovation_Policy_for_Climate_Change.pdf
- Pew Center on Global Climate Change:

U.S. technology and innovation policies: Lessons for Climate Change, November 2003, http://www.cleanenergystates.org/library/Reports/Pew_US-Technology_and_Innovation_Policies.pdf