

Appendix B

Government Policies and Increased Adoption of NGETs

The mechanisms through which government policy can affect the rate of adoption of Next Generation Environmental Technologies fall into four broad categories:

1. Direct funding and/or performance of research and development activities.
2. Economic incentives, including both tax incentives and subsidies.
3. Information dissemination, including direct dissemination, industry consultations, and voluntary programs.
4. Infrastructure support, including direct investment in infrastructure, creating an appropriate institutional environment, and education and training.

Government policies intended to affect adoption rates will generally include elements from more than one category. Particular mechanisms will be more or less appropriate as technologies mature.¹⁷⁰

Policy options, some examples of these policies that have affected NGETs, and a number of issues related to the use of these policies are summarized in the following table.

¹⁷⁰Robert Premus, "Moving Technology from Labs to Market: A Policy Perspective" *Int. J. Technology Transfer and Commercialization*, Vol. 1, Nos. 1/2, 2002, pp. 22-39. He looked at adoption of three environmentally friendly technologies and concluded that three policy options were needed: access to capital for startups, environmental standards reflecting true social costs of pollution, and government procurement for business growth in environmentally friendly industries.

Table B1. Policy Options Affecting NGETs.

Policy or Action	Intended Effects	Examples ¹⁷¹	Issues Associated with Policy Success ¹⁷²
<i>Funding R&D</i>	Enhance scientific understanding that can lead to new technologies.	<ol style="list-style-type: none"> 1. NSF Center at University of North Carolina/North Carolina State. 2. DOE's support to develop a biorefinery. 3. DOE's Office of Industrial Technologies. 4. EPA/NSF Technology for Sustainable Environment. 	<ol style="list-style-type: none"> 1. Level of federal funding vs. other initiatives may be insufficient. 2. Little coordination between funding agencies or focus. 3. Multidisciplinary efforts receive less funding. 4. Responsibility for environmental R&D is dispersed; no analogy: National Institutes of Health is to the FDA as X is to EPA.
<i>Purchases/ procurement</i>	Provide early markets that can speed commercial development of new technologies.	Government purchases of "green" power or recycled materials.	Can be difficulty in defining that products and processes should be defined as "green."
<i>Tax incentives/ disincentives</i>	Provide market signal to help firms internalize costs of hazards, encourage new investment.	<ol style="list-style-type: none"> 1. Landfill costs. 2. Depreciation rules favoring certain types of investment. 	A targeted approach difficult to use for promoting NGETs in general; can be difficult to set and/or adjust appropriate tax levels; can distort efficient economy.

¹⁷¹Most examples are found throughout the case studies in Appendix A.

¹⁷²These are issues discussed (1) at the NRC Workshop on the Environment: Challenges for the Chemical Sciences in the 21st Century, November 17–19, 2002, Irvine, Calif.; proceedings forthcoming, (2) at CHEMRAWN XIV Toward Environmentally Benign Products and Processes, Boulder, Colo., June 9–13, 2001; *Report of the Future Actions Committee* available at www.iupac.org, (3) in National Academy of Sciences, *New Tools for Environmental Protection: Education, Information, and Voluntary Measures*, Washington, D.C.: National Academies Press, 2002, (4) in Nicholas A. Ashford "Industrial Safety: The Neglected Issue in Industrial Ecology," *Journal of Cleaner Production*, Vol. 5, Nos. 1/2, March–June, 1997, (5) from D. L. Hjeresen, personal communication, November 2002.

		<p>3. Tradable permits—carbon tax, sulfur dioxide taxes.</p> <p>4. Dry Cleaning Environmental Tax Credit Act of 1999.</p>	
<i>Subsidies</i>	Encourage greater adoption of environmentally friendly processes.	Agricultural subsidies that encourage use of renewables (ethanol).	As with tax incentives, lobbying efforts for entrenched technologies may distort objective or make it difficult to encourage certain NGETs.
<i>Regulations: workplace/ emissions/ products</i>	Increase costs or eliminate processes and products that cause harm to the environment, workers, or those using a product.	<p>1. Various acts administered by EPA—from the Clean Air Act to Clean Water, Superfund, and TSCA; banning use of some chemicals in certain applications.</p> <p>2. Rules enacted by the Occupational Safety and Health Administration.</p> <p>3. Limits set by the FDA.</p> <p>4. Labeling requirements.</p>	<p>1. Permit limits may not be tight enough to encourage development of new environmental benign or inherently safer process.</p> <p>2. Regulations may favor the established vs. the new process; hurdles for the new process.</p> <p>3. Products banned in one country may still be exported to others (tetraethyllead, various pesticides).</p> <p>4. Small and “nonpoint” sources are difficult to regulate and enforce.</p> <p>5. Targets are single chemicals or one work practice where harm comes from collective effects.</p> <p>6. Negotiations with regulators can lead to commitment to develop NGETs.</p>
<i>Patent law</i>	Encourage investment in new technologies by	1. Several statutes such as the 1980 Bayh-Dole Act allowing federally funded research to yield patents	1. Process chemistry may be best protected as trade secrets; some process patents are more difficult to enforce than product patents.

	protecting firms' intellectual property; can enable technology transfer of proprietary green chemistry.	for those doing the work—enabling intellectual property to be licensed to industry. 2. Extensions or limitations on patent protection such as Waxman-Hatch Act.	2. Intellectual property can be a barrier to wide diffusion of NGETs.
<i>Information dissemination</i>	Encourage adoption by providing a wide range of technology and cost. Performance information on green chemistry-based technologies.	1. EPA's Presidential Green Chemistry Awards. 2. Sponsoring conferences and workshops by EPA, DOE, and NSF. 3. Sponsoring studies by National Research Council and others. 4. Books, papers by government or academic scientists. 5. Standard setting. 6. Emergency Preparedness and Community Right to Know Act gives public information on inventories and emissions. 7. Availability of Toxics Release Inventory with sources.	
<i>Industry consultations</i>	Encourage adoption of NGETs by industry by providing information on the cost and performance of new technologies.	1. Government and academic scientists as consultants to various firms or industry associations. 2. Nonprofit Zero Waste Alliance provides industry consultations.	Those in industry may not know they are "doing" green chemistry, may not call for assistance, or may not want to disclose proprietary information.

<i>Voluntary programs</i>	Encourage adoption through behavior change; perceptions of good citizenship.	<ol style="list-style-type: none"> 1. Recycling programs. 2. Encourage nongovernmental standard setting. 3. Encourage initiatives of associations: Responsible Care® (American Chemistry Council), Inherently Safer Processes (American Institute of Chemical Engineers). 4. Firms publishing environmental annual reports with commitments on emissions, energy reductions. 5. "Green consumerism" may promote voluntary actions. 	<ol style="list-style-type: none"> 1. Backup of regulation or anticipation of future regulation may be an important driving force for voluntary programs. 2. Programs may not be accepted broadly across an industry.
<i>Infrastructure support and development</i>	Enables diffusion through provision of necessary foundation.	<ol style="list-style-type: none"> 1. Establishment of recycling centers. 2. Support for networks, user facilities at National Laboratories. 	
<i>Education and training</i>	Accelerated diffusion by increased knowledge of principles and approaches of NGETs.	<ol style="list-style-type: none"> 1. Support for green chemistry programs at universities. 2. Support for many workshops around the world. 	Green chemistry programs in universities may be drawing more talent into the study of chemistry.