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Cleaner Technology, Pollution Prevention and Environmental Regulation

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ARTICLES

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INTRODUCTION

Preventing pollution, rather than controlling it after it has been produced, seems like such a good policy on its face that one wonders how executing it could be so problematic. Business has embraced the idea of prevention, and the Environmental Protection Agency (EPA) has adopted explicit supporting policies and conducted many pilot projects. The recently adopted National Environmental Technology Strategy is broadly supportive:

> We are progressing from an environmental paradigm based on cleanup and control to one including assessment, anticipation, and avoidance . . . .
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> The environmental problems of greatest immediate concern have changed over the past quarter of a century, and the technologies required to address those problems have changed as well. In the 1970's, environmental protection focused on "end-of-pipe" equipment for controlling air and water pollution. In the 1980's, the physical cleanup of waste sites received particular attention. Today, environmental protection is beginning to involve changes in the fundamental ways our energy, food, fiber, shelter and consumer goods are produced. The emphasis has shifted from the control and remediation of pollution to

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the avoidance and monitoring of many kinds of environmental harm.[1]

Prevention is important for three main reasons.[2] First, controlling pollution after it has been produced has only limited potential to achieve further environmental protection. While pollution control's emphasis on the end-of-the-pipe has already accomplished substantial environmental protection, further improvements will be increasingly difficult and expensive. Today, pollution control leads to more and more rules and standards, but with less and less actual environmental improvement to show for

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1. NATIONAL SCI. & TECH. COUNCIL, BRIDGE TO A SUSTAINABLE FUTURE: NATIONAL ENVIRONMENTAL TECHNOLOGY STRATEGY 4, 8 (1995); *see* Nicholas A. Ashford, *An Innovation Based Strategy for the Environment* [hereinafter Ashford, *Innovation Based Strategy*], *in* WORST THINGS: THE DEBATE OVER RISK-BASED NATIONAL ENVIRONMENTAL POLICIES 275 (Adam M. Finkel & Dominic Golding eds., 1994).

> Technological change is now generally regarded as essential in achieving the next major advances in pollution reduction. The necessary technological changes include the substitution of materials used as inputs, process redesign, and final product reformulation. Initiatives for focusing on technological change need to address multimedia pollution and to reflect fundamental shifts in the design of products and processes. Distinguished from end-of-pipe pollution control, those new initiatives are known as pollution prevention, source reduction, toxics-use reduction, or clean technology.

Id. at 276.

2. These advantages are surveyed and the literature discussing them is collected in Kurt A. Strasser, *Preventing Pollution,* 8 FORDHAM ENVTL. L.J. 1, 7-15 (1996).

The definition of pollution prevention has proved contentious. EPA wishes to limit the term to source reduction of pollutants, with recycling or reuse defined as separate categories. *See* Pollution Prevention Act of 1990, 42 U.S.C. § 13,101 (1994); Environmental Protection Agency Pollution Prevention Strategy, 56 Fed. Reg. 7,849, 7,854 (1991). The agency's usage emphasizes a policy preference for prevention over other waste reuse, treatment or disposal methods.

In this Article, I intend a broader use of the term: one that includes any reduction in the creation of waste residuals that are not reused. Thus, by "prevention," I mean to include reducing the generation of wastes at the source (source reduction) as well as internal and external reuse of wastes in recycling or other operations. This broader usage is more supportive of the needed business programs.

them. Second, prevention is a strategy that can support both environmental protection and economic development goals, by harnessing the creative energy of business to serve both. "Encouraging technological changes for production purposes and for environmental compliance purposes must be seen as interrelated rather than separable activities."[3] Pollution prevention shows most clearly that the choice between economic growth or environmental protection, though oft posed, is false. Third, pollution prevention is more effective environmental protection because it treats the problem — the creation of pollution — rather than simply shifting it around to less strictly regulated media.

To prevent pollution, business must do much more than simply add clean-up gadgets at the end-of-the-pipe or the smokestack. Business organizations and the people in them have a central role in preventing pollution. Successful pollution prevention requires an effort inside the plant, and even earlier when designing products and choosing raw materials. Pollution is the unfortunate byproduct of producing goods and services. The people who do the producing will have a primary role in learning to produce with less pollution; ideally with none. This will require changes in raw materials, production processes and technologies, and in products themselves. Innovative ideas and organizational support to implement them are both essential. This Article will consider how the traditional environmental regulatory system encourages and discourages business from these new ways of acting and thinking.[4] In particular, it will examine how the last three

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3. Ashford, *Innovation Based Strategy*, *supra* note 1, at 276. There is some case study evidence that research and development aimed at regulatory compliance can also lead to other innovative improvements, such as the effort to develop lead-free gasoline which also created improved catalysts. *See* Nicholas A. Ashford & George R. Heaton, *Regulation and Technological Innovation in the Chemical Industry*, 46 LAW & CONTEMP. PROBS. 109, 132 (1983) [hereinafter Ashford & Heaton, *Chemical Industry*]; Nicholas Ashford et al., *Using Regulation to Change the Market for Innovation*, 9 HARV. ENVTL. L. REV. 419, 435-36 (1985) [hereinafter Ashford et al., *Using Regulation*]. *See, e.g.*, Environmental Protection Agency Pollution Prevention Strategy, 56 Fed. Reg. 7,849, 7,853 (1991) (explaining that legal regulation may not catch liquid pollutants that are transferred to the air by vapor).

4. A recent article discusses what pollution prevention requires of business and the management approaches and other changes that will be necessary to achieve it. *See generally* Strasser, *supra* note 2.

stages of the pollution control regulatory system can encourage or discourage pollution prevention.

Part I will present the basic regulatory background. Part II will survey the business context in which innovation occurs to determine the industry and firm characteristics that have particular importance for environmental innovation. The following sections will then evaluate the traditional regulatory system's positive and negative effects on pollution prevention and environmental technology development. The process of agency standard-setting will be discussed in Part III. Parts IV and V will address permitting and enforcement, respectively.[5] In addition, this Article will suggest that whereas a compliance/enforcement culture may hinder prevention efforts, a multimedia approach, which encourages innovation and dissemination of technology, may yield better results.

I. Environmental Regulation and Pollution Prevention

Traditional environmental regulation has been primarily aimed at achieving pollution control, rather than pollution prevention. Thus, its primary concern has been to set and enforce standards limiting the discharge of pollutants from the end-of-the-pipe or the smokestack, or standards for storage and treatment of wastes. Typically, this process entails four stages.[6] First, a statute is passed that sets guidelines for the amount of pollutant release that will be allowed. Increasingly, these statutory commands have become more detailed. These medium-specific statutes typically authorize EPA to set the precise limits for pollutant discharges from individual sources, or for pollutant concentrations in the receiving medium.[7] In the second stage, EPA conducts a rulemaking pro-

5. 80% of state programs are reported to involve voluntary promotional efforts and 20% are regulatory. *See* General Acct. Off., Pollution Prevention: EPA Should Reexamine the Objectives and Sustainability of State Programs 3, 20 (GAO-PEMD-94-8, 1994).

6. The process described here is for federal standards with state enforcement. States are usually authorized to set their own standards to supplement and extend the federal ones and, when they do so, go through similar stages. *See, e.g.*, Peter J. Fontaine, *EPA's Multimedia Enforcement Strategy: The Struggle to Close the Environmental Compliance Circle*, 18 Colum. J. Envtl. L. 31 (1993).

7. *See id.* at 49.

ceeding, sets the standards, and then typically defends them with varying success in the likely court challenge.[8] In the third stage, regulators issue permits for the discharge of pollutants for specific sources, while in the fourth, compliance with the permit is monitored and enforcement actions are brought when needed. The federal statutes authorize delegation of these last two stages to the states, under federal supervision, and most states have sought and received authority to issue permits and conduct their own compliance and enforcement operations.[9]

At first blush, it seems that a regulatory system that successfully controls pollution will inevitably motivate polluters to prevent that pollution at the outset. To a degree, the traditional regulatory system has achieved some substantial success in this regard over the last twenty-five years.[10] The present regulatory system, however, oriented as it is to pollution control rather than pollution prevention, has some inadvertent but quite serious disincentives to pollution prevention.

Four broad themes describe the extent to which traditional environmental regulation motivates — and fails to motivate — business to prevent pollution. The first theme is that, despite Con-

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8. *See id.* at 51-53.

9. EPA reports that, as of Oct. 10, 1997, 43 states had approved permitting programs, 37 were approved to regulate federal facilities, 31 had approved retreatment programs, and 42 had approved general permit programs. As of January 1, 1994, 40 states had approved programs under the National Pollution Discharge Elimination System; 35 of these had authority to regulate federal facilities, 28 had approved pretreatment programs, and 39 had approved general permit programs. As of 1992, 46 states had approved authorization for administering the base program. *See* 4 WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW, HAZARDOUS WASTES; *States Having Approved Programs from the National Pollution Discharge Elimination System (NPDES)*, Env't Rep. (BNA), Jan 28, 1994, at 6,111.

10. For example, from the 1970 enactment of the Clean Air Act to 1994, the combined emissions of the six principal air pollutants decreased 24% while U.S. population increased 27%, vehicle miles traveled increased 111% and gross domestic product increased 90%. During this period the introduction of unleaded gas decreased lead emissions by 98%. *See* EPA, OFF. AIR QUALITY PLAN. & STANDARDS, AIR QUALITY TRENDS 4 (EPA-454-F-95-003, 1995).

gressional, EPA and White House policy statements,[11] pollution control remains the current policy and prevention is pursued only marginally, if at all. To be sure, there is a long history of pilot projects and other one-time efforts that have experimented with a prevention approach.[12] However, the sheer number of these projects, the extent of this history, as well as the unending and uncoordinated progression of new initiatives, show that pollution prevention has not yet been institutionalized within the regulatory bureaucracies. Accordingly, the current system fails to support the business efforts and initiatives that prevention demands.

The second theme is that the regulatory system could be a most potent motivator of pollution prevention by business. Clearly, the regulatory system is a critically important motivator of business behavior.[13] Of all environmental policies, the regulatory system sends the sharpest and loudest message to business, although unfortunately not always the clearest or most consistent one. The regulatory system is built around mandates and penalties that business ignores only at its considerable peril. The evidence suggests that, even in pollution prevention programs, business spends most of its environmental protection budget on compliance rather than on prevention.[14] Business responds to the regulatory system; that system will determine whether the business response includes pollution prevention.

Further, the regulatory system determines what new pollution prevention technology will be developed. The standards set in the regulatory system will effectively define at least the minimum market for environmental technology. If regulators do not set and enforce standards that require new technology to be adopted, business has little incentive to develop and deploy it. Conversely, when new technology is developed, if regulators do not approve it in their permitting and enforcement decisions, then that technology will not be profitable and ultimately will

11. *See id.* at 13.

12. *See id.*

13. *See* Ashford & Heaton, *Chemical Industry*, *supra* note 3, at 128-34 (surveying the effects of regulation on business profitability and related issues).

14. *See* Strasser, *supra* note 2, at 9.

not survive in the market. A history of such disapproval will discourage firms from even developing new technology in the first place.

The third theme is that the present regulatory system could support business' pollution prevention efforts without fundamental statutory change. Several specific provisions of the statutes authorize flexibility in writing standards and in issuing and enforcing permits.[15] This flexibility affords regulators a measure of discretion that they can exercise to encourage business to prevent pollution. In addition, regulators could coordinate their efforts to partially accomplish multimedia results, particularly with permitting and compliance. Finally, EPA can support more prevention-friendly regulation by the states: through supervision, guidance and in grants which support pollution prevention.

The last theme is that a truly robust pollution prevention and environmental technology policy would require radical change that embraces fundamentally different approaches to environmental protection regulation. To encourage prevention, environmental regulation should adopt a multimedia approach, looking broadly at all the environmental consequences of a particular business operation across all environmental media. Present regulation tends to focus narrowly on one environmental medium at a time, e.g. air, water or land based waste disposal. This single-medium philosophy leads, in turn, to a focus on the end-of-the-pipe, and the technology available for application there. Effective pollution prevention by business requires new technology within the plant and business decisions that embrace it.

Multimedia regulation should ideally be organized by industrial sectors rather than by the different environmental media. Organization by industrial sectors will encourage the agencies to develop greater expertise and sophistication in assessing the technology and innovation possibilities within each business sector. Fundamental changes in regulatory thinking, as well as a wholesale reorganization of regulatory agency structure will be essential; rewriting of the basic environmental statutes to require multimedia regulation would further this goal.

15. *See* Ashford & Heaton, *Chemical Industry, supra* note 3, at 137-42; *infra* Parts III.F, IV.B & V.B.

Regulators must develop a clearer idea of what business must do to prevent pollution and consider the industry and firm specific characteristics that might affect it.[16] Environmental technological innovation is influenced by many factors other than the regulatory system.

II. Industry and Business Context for a Prevention/Innovation Policy

A. *Introduction*

Pollution prevention usually requires technological changes in the firm's products and production.[17] The many different possible changes include process modifications, product design alterations, materials substitutions, or combinations thereof.[18] Of equal importance are managerial and organizational changes, from the adoption of assembly lines to the adjustment of individual workers' job descriptions.

This section will survey the basic ideas about how technological change occurs, in terms of business, industry, and regulatory

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16. This Article builds on a related article that examines pollution prevention from a business perspective. *See generally* Strasser, *supra* note 2. The concern there was to survey and analyze the internal company policies and cultural factors that promote or retard pollution prevention. *See id.* at 3-5.

17. *See* Nicholas A. Ashford, *Understanding Technological Responses of Industrial Firms to Environmental Problems: Implications for Government Policy* [hereinafter Ashford, *Technological Responses*], *in* ENVIRONMENTAL STRATEGIES FOR INDUSTRY 277, 278 (Kurt Fischer & Johan Schot eds., 1993).

> Technological change can involve both technological innovation and diffusion. *Technological innovation* is both a significant determinant of economic growth and important for reducing health, safety, and environmental hazards. It may be major, involving radical shifts in technology, or incremental, involving adaption of prior technologies. Technological innovation is fundamentally different from *diffusion,* which is the widespread adoption of technology already developed.

Id. (citation omitted); *see also* George R. Heaton, Jr., Regulation and Technological Change, Symposium; Toward 2000: Environment, Technology and the New Century 4 (June 13-15, 1990) (transcript on file with author) [hereinafter Heaton, Regulation and Technological Change].

18. *See* Ashford, *Innovation Based Strategy, supra* note 1, at 276.

factors. Regulation alone does not — and cannot — unilaterally determine business behavior. Rather, regulation, business and industry factors interact, each influencing technological change in subtle and interrelated ways.[19] A better understanding of technological change in business will enable regulators to craft a regulatory system that is more supportive of such change.[20]

> In creating an atmosphere conducive to innovation, a regulator must assess the innovative capacity of the target industrial sector . . . . . The analysis should focus principally on the process of technological *change* within the possible responding sectors. The regulator should analyze a sector's "innovative dynamic" rather than its existing, static technological capability . . . . The assessment should include an analysis of the industry's existing technological capabilities as well as a reasoned prediction of its innovative potential under the challenge of regulation.[21]

It is not surprising that no single theory or body of evidence explains technological change. Technological change results from the interaction of a single firm with a multitude of internal and external factors. While some of these factors apply to many firms and industries, many others are unique or idiosyncratic to

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19. *See* Alan Irwin & Philip Vergragt, *Re-Thinking the Relationship Between Environmental Regulation and Industrial Innovation: The Social Negotiation of Technical Change*, 1 TECH. ANALYSIS & STRATEGIC MGMT. 57 (1989).

20. *See* Ashford, *Innovation Based Strategy*, *supra* note 1, at 299-300.

> The value of this theory of innovation is that it provides a rationale upon which the regulatory agency may fashion a regulation aimed at the industry most likely to achieve a regulatory goal and by which the private sector can develop a more appropriate response to environmental problems . . . . In sum, regulations must be designed explicitly with technological considerations in mind -that is, regulations should be fashioned to elicit the type of technological response desired.

Id.

21. *See* Ashford et al., *Using Regulation*, *supra* note 3, at 422.

> Three questions are central for regulators:
> [1] What technological response is desirable?
> [2] Which industrial sector is most likely to diffuse or to develop the desired technology?
> [3] What kinds of regulation and incentives will most likely elicit the desired response?

Ashford, *Innovation Based Strategy*, *supra* note 1, at 300.

a firm, its market and technological contexts or its specific industry sector. Further, technological change is often the cumulative result of a number of small changes, taking place over time, rather than one dramatic application of a single large insight. The total effect of such an accumulation is likely to vary among firms and industries.

Despite this array of factors, technological change is not random. Technological change is largely predictable if one properly considers firm and industry factors that form its context.[22] The manner in which a firm embraces technological change reflects not only the firm's social and economic context, but also its specific technical and managerial capabilities and limitations.

Ultimately, technology-friendly regulation requires a comprehensive understanding of the essential stages of technological development: invention, innovation, and diffusion.[23] Invention is the creation of new fundamental scientific or technical knowledge. As most prevention efforts turn on new applications of familiar principles, however, the invention stage is of limited relevance.[24] The innovation stage, in contrast, is central to pollution prevention. Innovation is the first successful application of basic scientific knowledge to create new commercial processes or products. It typically requires a substantial creative effort, as well as substantial financial and organizational support for development and implementation. Accordingly, regulation can have dramatic effects on innovation, both positive and negative.

The diffusion stage entails the widespread adoption of successful innovations throughout an industry and across industries. The evidence indicates that most technological responses to regulation involve diffusion rather than innovation,[25] but the distinction between them in practice is often unclear. Diffusion and innovation arise in different firm and industry contexts, and regulators must have a clearer understanding of these dynamics in order to properly assess the prospects for favorable technological change in a given situation.

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22. *See* Ashford, *Innovation Based Strategy, supra* note 1, at 299; Ashford et al., *Using Regulation, supra* note 3, at 428-29; Heaton, Regulation and Technological Change, *supra* note 17, at 9-12.

23. *See* Heaton, Regulation and Technological Change, *supra* note 17, at 4.

24. *See id.*

25. *See* Ashford, *Innovation Based Strategy, supra* note 1, at 303.

B. *Firm and Industry Characteristics Associated with Technological Change*

Recent studies have identified several key factors that accord a degree of predictability to the process of technological change.[26] One factor is the maturity of the firm's core technology and manufacturing processes, which offers substantial predictive power.[27] The type and degree of a firm's innovation is heavily influenced by whether the firm or industry's core technology is relatively new and still fluid, or more mature and rigid.

A new, fluid technology favors major product changes for several reasons. First, it is easier for a firm to implement such changes when a new product's performance criteria are uncertain and still changing. Second, a firm is less likely to have invested heavily in specialized manufacturing equipment for the new product. Third, customers for a new product are more amenable to major changes in its earlier stages.[28]

As the product and the firm's production technology mature, however, change typically takes the form of incremental process modifications or minor product improvements.[29] During this

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26. *See id.* at 299; Ashford et al., *Using Regulation, supra* note 3, at 427-29; Heaton, Regulation and Technological Change, *supra* note 17, at 9-12.

27. *See* William J. Abernathy & James Utterback, *Patterns of Industrial Innovation,* TECH. REV., June/July 1978, at 41. This theory is developed and expanded upon in JAMES M. UTTERBACK, MASTERING THE DYNAMICS OF INNOVATION ch. 4 (1994). The theory and its implications for regulatory policy are discussed in Ashford et al., *Using Regulation, supra* note 3, at 427-29.

28. *See* UTTERBACK, *supra* note 27, at 82-83, 92-95; Heaton, Regulation and Technological Change, *supra* note 17, at 5.

29. A classic illustration is the evolution of manufacturing of Model T automobile engines:

> During the four-year period before Henry Ford produced the renowned Model T, his company developed, produced, and sold five different engines, ranging from two to six cylinders. These were made in a factory that was flexibly organized much as a job shop, relying on trade craftsmen working with general-purpose machine tools not nearly so advanced as the best then available. Each engine tested a new concept. Out of this experience came a dominant design -the Model T: and within 15 years 2 million engines of this single basic

"transitional" phase,[30] manufacturing machinery becomes increasingly specialized in order to increase efficiency and reduce costs. Consequently, major product or process changes become much more difficult.[31] The firm is thus disinclined to make such changes without a powerful external stimulus, such as new regulation or the creation of a new competitive product.[32]

The actions of PCB producers, for example, illustrate how the fluidity or rigidity of a firm's technology and management influence its choices regarding technological change.[33] Monsanto, at one time the sole United States producer of PCBs, initially responded to public concerns about their effects by simultaneously restricting their sale and attempting to develop a more biodegradable formula.[34] Although an innovation in capacitor design reduced the demand for PCBs, Monsanto chose to leave the market three years before Congress banned PCBs outright in

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> design were being produced each year (about 15 million all told) in a facility then recognized as the most efficient and highly integrated in the world. During that 15-year period there were incremental -but no fundamental -innovations in the Ford product.

Abernathy & Utterback, *supra* note 27, at 44.

30. *See* UTTERBACK, *supra* note 27, at 82-83, 96 (describing the transitional phase in more detail).

31. *See id.* at 96.

> Any small change in either product or process is likely to be difficult and expensive and require a corresponding change in the other. Even what may seem like a small change -such as shifting production from manual to electric typewriters -is viewed as revolutionary by manufacturing, which by now has fully automated operations geared to highly efficient, low-unit-cost production of highly specified products.
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> Organizationally, the day of the inventor has given way in the specific phase to the tenders -that is, those who monitor and control the smooth working of the production system.

Id.

32. *See id.*

33. *See* Kathleen Rest & Nicholas A. Ashford, *Regulation and Technological Options: The Case of Occupational Exposure to Formaldehyde*, 1 HARV. J. L. & TECH. 64, 76 (1988) [hereinafter Rest & Ashford, *Formaldehyde*].

34. *See id.*

1979.[35] In response, however, five downstream users of PCBs developed substitute products and made new entries into the market.[36] Unlike Monsanto, these firms were not committed to mature, rigid production technology, and consequently, they could respond to the situation more innovatively.[37]

The semiconductor industry from 1950 through 1968 offers a second example of how firms at different maturity stages make technological changes.[38] Eight of the thirteen most important product innovations occurred in the first seven years.[39] Three successful new firms were responsible for half of the major product innovations, but only one of nine process innovations.[40] In contrast, established firms entering the business at that time responded to competition as established firms would be expected to do — they emphasized process innovations.[41] The new firms were more successful during this early period, presumably because product innovation was a more successful competitive strategy.[42] However, as the products matured, production costs and productivity became more important competitively, and incremental process changes became a more successful competitive strategy.[43] At each stage, the technical maturity of the industry provided a basis for predicting competitive success of different

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35. *See* 15 U.S.C. §§ 2605(e)(2)(A), (e)(3)(A) (1986). For a discussion of this episode, see Ashford et al., *Using Regulation, supra* note 3, at 432-33; Rest & Ashford, *Formaldehyde, supra* note 33, at 76.

36. *See* Ashford et al., *Using Regulation, supra* note 3, at 433; Rest & Ashford, *Formaldehyde, supra* note 33, at 76.

37. *See* Rest & Ashford, *Formaldehyde, supra* note 33, at 76.

> When faced with the possibility of environmental regulation, the sole supplier of a product in a rigid productive segment attempted some modest process innovation and ultimately withdrew from the PCB market. The new entrants responded to the EPA ban with radical product innovation, developing PCB substitutes for transformers and capacitors.

Id.

38. *See* Abernathy & Utterback, *supra* note 27, at 42-43.

39. *See id.* at 2.

40. *See id.*

41. *See id.*

42. *See id.*

43. *See id.*

strategies adopted by different firms.[44]

An extensive study of waste reduction activity at twenty-nine chemical industry plants provides further broad support for the model.[45] Efficiency-oriented changes to processes and equipment accounted for forty-four percent and thirty-four percent of all the waste reduction activities undertaken, respectively, and these were the fastest increasing categories.[46] In contrast, the more innovative changes, chemical substitutions and product reformulations, were used in ten percent and five percent of the activities respectively, and the relative frequency changed little over the study period.[47] Product changes were the most effective in reducing wastes, however, averaging a one hundred percent waste stream reduction, while process and equipment changes each averaged about seventy percent reductions.[48]

As a firm's technology matures, its management tools and organization structure that support technological change also evolve.[49] Research and development become more formalized in operation and structure, having more clearly defined and incremental goals. The entrepreneurial role so critical to the earlier rapid changes gives way to a more managerial role, which is reflected throughout the organization.[50] These cultural changes within the firm are yet another example of different business responses to fluid technologies and rigid ones.

This theory has proven to be an effective predictor of the impact of regulation on the process of technological change. A careful review of the case studies and other research on the chemical industry noted that firms within a given sector tended to respond uniformly to a regulatory stimulus, concluding:

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44. *See id.*

45. *See* MARK H. DORFMAN ET AL., ENVIRONMENTAL DIVIDENDS: CUTTING MORE CHEMICAL WASTES (Inform, 1992). This study built on an earlier one by some of the same authors and the same organization: DAVID J. SAROKIN ET AL., CUTTING CHEMICAL WASTES (Inform, 1985).

46. *See* DORFMAN, ET AL., *supra* note 45, at 48-49.

47. *See id.*

48. Chemical substitutions averaged 48% reductions. *See id.* at 50.

49. *See* UTTERBACK, *supra* note 27, at 83.

50. *See id.*

> [t]he response uniformity within productive segments suggests that the character of the existing technology does indeed dominate the response to regulation, as would be the case for other market stimuli. Second, the proportion of product and process responses to regulation closely resembles the expected balance of product to process innovations occurring in the segment absent regulation. Thus, "fluid" industries tend to respond to regulation with product modifications, and "rigid" segments tend to have more process responses than product changes. "Transition" industries, in contrast, exhibit both product and process changes and a greater overall amount of change than fluid or rigid segments. These responses to regulation are highly consistent with the usual pattern of innovation in the absence of regulation.[51]

While dramatic innovative changes are most appealing, the cumulative impact of incremental change can be as large and significant. The history of the electric light bulb industry shows that incremental process changes can cumulatively lead to dramatic efficiency and product improvements:

> By 1909 the initial tungsten filament and vacuum bulb innovations were in place; from then until 1955 there came a series of incremental changes — better metal alloys for the filament, the use of "getters" to assist in exhausting the bulb, coiling the filaments, "frosting" the glass, and many more. In the same period the price of a 60-watt bulb decreased (even with no inflation adjustment) from $1.60 to 20 cents each, lumens output increased by 175 per cent, the direct labor content was reduced more than an order of magnitude, from 3 to 0.18 minutes per bulb, and the production process evolved from a flexible job-shop configuration, involving more than 11 separate operations and a heavy reliance on the skills of manual labor, to a single machine attended by a few workers.[52]

To effectively exploit the business potential for environmental technological change, regulators must understand both dramatic and incremental change and maximize the chances for each.

Firms with more flexible organizations and operating styles are more likely to embrace change, in response to both regulation and to other stimuli. "Flexibility in companies tends to be in part a result of their size, in part a question of manufacturing

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51. Ashford & Heaton, *Chemical Industry*, *supra* note 3, at 155-56; *see* Ashford, *Innovation Based Strategy*, *supra* note 1, at 298-99; Heaton, Regulation and Technological Change, *supra* note 17, at 11.

52. Abernathy & Utterback, *supra* note 27, at 43-44.

process design, and in part attitudinal."[53] Flexibility will be part of the firm's organizational culture and its fundamental attitudes toward technological change.[54] The firm's self image as innovator, as well as its skill mix and technological base, will all be important.

Where the change is a radical innovation, three factors are particularly important to understanding whether it is likely to come from insiders or outsiders.[55] First, radical innovations to assembled products are most likely to come from outsiders, while those to non-assembled products are most likely to come from insiders.[56] Second, radical innovations that create a new market or expand the existing one tend to come from outsiders, while those that give rise to substitute products have about an equal chance of coming from either insiders or outsiders.[57] Innovations

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53. Ashford & Heaton, *Chemical Industry*, *supra* note 3, at 126. The two Inform studies reached different conclusions on the correlation between the type of manufacturing process -batch or continuous operation -and the type of waste reduction practices likely to be undertaken. The 1985 Inform study, SAROKIN ET AL., *supra* note 45, at 114, found such a correlation. However, the later expanded study, DORFMAN ET AL., *supra* note 45, at 35, expanded on this effort and determined that the resulting differential was not statistically significant.

54. For a review of the impact of corporate culture on innovation see Strasser, *supra* note 2, at 34. For an interesting discussion of the impact of corporate culture and business context on the structure and success of two different waste reduction programs, see Peter B. Cebon, *The Myth of Best Practices: The Context Dependence of Two High-Performing Waste Reduction Programs*, *in* ENVIRONMENTAL STRATEGIES FOR INDUSTRY, *supra* note 17, at 167.

55. Such radical innovations are called "discontinuous" in the business literature. *See* UTTERBACK, *supra* note 27, at 200-09. This theory is based on a careful review of 46 specific case studies. *See id.* at 203.

56. *See id.* at 208.

57. Professor Utterback explains innovations that expand the market:

> The replacement of the vacuum tube by the transistor and later by the integrated circuit has increased the sales of the electronics industry from several billion dollars to hundreds of billions. The replacement of piston aircraft engines by turbojets has correspondingly dramatically reduced the costs and increased the seat miles flown by commercial aircraft. The advent of the electronic calculator has made such equipment commonplace rather than something rarely encoun-

that broaden the market make room for new firms, while innovations that lead to substitutions lead established firms to fight tenaciously for market share.[58] Third, insiders are more likely to come up with innovations that enhance their basic technical and business competencies, while outsiders' innovations often call for new competencies, effectively (if inadvertently) destroying or devaluing the existing competencies by replacing them with others.[59]

Each of these three characteristics is important, but the most robust theory comes from using them in combination. Thus, radical innovations are most likely to favor outsiders, and disrupt the status quo, where they change assembled products, expand established markets or create new ones, and destroy existing competencies. Conversely, radical innovations are most likely to come from insiders when they involve non-assembled products, offer substitutes for existing products in the same markets, and enhance core competencies. Where two of the disruptive factors are present, outsiders were responsible for sixteen out of eighteen innovations; where only one factor was present, the odds were about fifty-fifty.[60]

Industry structure factors must also be considered. The relative size of firms in the industry is one such factor. While the association between firm size and innovation has been much studied, "[t]he most notable feature of this considerable body of empirical research on the relationship between firm size and innovation is its inconclusiveness."[61] Larger firms do proportionately

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> tered. The advent of Eastman Kodak's camera and roll film system transformed photography from a small professional market to the large and now familiar amateur market.

Id. at 204-05.

58. *See* FREDERIC M. SCHERER & DAVID R. ROSS, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 633-35 (3d ed. 1990) (laying out the formal geometry showing why dominant firms will fight to retain their dominance when threatened by technological change).

59. *See* UTTERBACK, *supra* note 27, at 206-07. "For example, the skills of mechanical watch manufacturers or vacuum-tube producers were rendered irrelevant by quartz watches and integrated circuits, respectively." *Id.* at 207.

60. *See id.* at 208.

61. Wesley M. Cohen & Richard C. Levin, *Empirical Studies of Innovation and Market Structure*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZATION 1071 (Richard Schmalensee & Robert D. Willig eds., 1989).

more structured research and development activity, although smaller firms get proportionately more patents.[62] Innovation demands a degree of flexibility in management and operations that may be easier for small and medium sized firms.[63] However, innovation also demands resources and a continuing commitment to development that may pose problems for the smallest firms.[64] When the change sought is diffusion of existing technology, the ability to finance this effort is likely to be greater with medium-sized and large firms. Further, there may be economies of scale to diffusion, particularly where it is undertaken to achieve or surpass regulatory compliance, and this will surely favor larger firms.[65]

The "dynamic efficiency" of the markets in which firms operate is also important. Developed by Burton Klein, the concept of dynamic efficiency examines the market structures that are most supportive of innovation.[66] This contrasts with the static efficiency that is at the heart of most conventional microeconomics. Static efficiency is the most effective use of resources within fixed alternatives. Dynamic efficiency, in contrast, seeks to account for constantly shifting alternatives and to maximize the potential for innovation. Several conditions are important. Entry must be open to new entrants with better technologies; entrepreneurial risk-taking must be competitively successful; and sticking with the technological status quo must be less successful. A market structure that supports rivalrous behavior among firms in the industry

62. *See* SCHERER & ROSS, *supra* note 58, at 654-56; Cohen & Levin, *supra* note 61, at 1067-74.

63. *See id.*

64. *See id.*

65. *See* Ashford & Heaton, *Chemical Industry, supra* note 3, at 126-27. There is some evidence that such economies of scale in regulatory compliance with TOSCA's regulatory requirements may have discouraged innovation from the smaller firms which had been the most innovative, although the particular studies do have some difficulties. *See id.* at 148-49; *see also* UTTERBACK, *supra* note 27, at 191 (concluding that smaller firms are more likely to bring forth radical product innovations, but that a certain size is needed to support the investment required for incremental process innovation).

66. BURTON KLEIN, DYNAMIC ECONOMICS (1977). For a good, short summary of this work, see UTTERBACK, *supra* note 27, at 86-90; Ashford, *Innovation Based Strategy, supra* note 1, at 293-95; Ashford & Heaton, *Chemical Industry, supra* note 3, at 114.

and new entrants is an important condition. Characteristics that support technological change by individual firms, discussed above, will make them more dynamically efficient.

The external market demand for technological change will also be an important factor. Early studies of particular business innovations distinguished between "market-pull" and "technology-push" innovations.[67] The "market-pull" innovations, developed in response to customer demand, tended to be substantially more successful than "technology-push" innovations that resulted from the exploitation of a research-based technology of undemonstrated market value.[68]

In the context of environmental technological change, "market-pull" may be manifested in two unusual ways. First, environmental regulation can be tailored to create a "market-pull" for new technology.[69] Second is the influence of green, or greener, consumers. Increasingly companies are concerned that their buyers consider them to be environmentally responsible, whether the buyers are other companies buying intermediate goods or ultimate consumers.[70] It is difficult to gauge the importance of environmental responsibility as a market demand determining factor, but its impact on corporate environmental responsibility appears to be growing.

There is much for sophisticated regulators to know about the process of technological change within companies and how regulation can influence it. The fluidity, or rigidity, of a firm's core technology is a critically important factor in evaluating its attitude toward change and the kinds of change it is likely to make.[71] Other company and industry specific factors include firm size, the degree of flexibility, the organizational culture, the skill mix, technological base, and self-image. Beyond the context of an individual firm, are upstream or downstream firms likely to offer the needed technological change, whether they are new entrants, industry suppliers, pollution control firms, or government or academic research laboratories? Is the market structure one

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67. *See* Ashford & Heaton, *Chemical Industry*, *supra* note 3, at 111-12.

68. *See id.* at 112.

69. *See id.* at 114.

70. *See* Strasser, *supra* note 2, at 22-25 (discussing companies' concern with the environmental performance of their suppliers).

71. *See* Ashford & Heaton, *Chemical Industry*, *supra* note 3, at 112.

that supports and promotes dynamic efficiency? Finally, the degree of external demand for environmental technological change must be considered.

In order to make traditional regulation more accommodating to pollution prevention and technological change, all of these factors must be considered in crafting regulatory standards. Over the past twenty-five years, discharge and storage standards have led to some substantial technological change.[72] Further progress requires that regulators act with a better appreciation of the business dynamics of technological change.

III. SETTING STANDARDS FOR EMISSIONS, DISCHARGES, AND CONTAINING WASTES

A. *Introduction*

This section will evaluate the impact of environmental regulatory standard-setting on the process of pollution prevention and environmental technological change. While specific standards can be specified in legislation, legislation typically sets only a general objective and then authorizes the agency to make specific rules to implement it.[73] There are prominent exceptions to this in environmental law, but even these rely on agency rulemaking in setting the precise standards for individual sources.[74]

Standard-setting is the core of environmental regulation. In setting the criteria for discharge permits or permission to sell new or existing products, it also determines the flexibility that the permitting process will have in relation to new technology. Similarly, standards set the parameters for compliance and enforcement policy. To the extent that they authorize alternative permitting or compliance assurance policies, as well as alternative deadlines for compliance, they may be more or less friendly to technological change.

The environmental protection standards that agencies set are prime motivators of business behavior aimed at environmental

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72. *See* Strasser, *supra* note 2, at 35-46.

73. *See* Clean Air Act (CAA), 42 U.S.C. § 7412(d) (1995) (providing the regulatory agencies with ample powers to formulate standards).

74. *See id.* § 7412(d) (a prominent example of a detailed provision in the CAA).

technological change. While business behavior proper will determine the extent and quality of environmental technological change, "regulations are the rules that constrain the actors in the game of technological change. . . ."[75] This section considers what kinds of regulatory commands, used in what firm and industry situations, tend to induce diffusion of existing technology and what kinds encourage innovation to develop new technology. Are product standards or emissions standards more effective?

There is substantial disagreement about the general impact of regulation on technological change. One well-established school argues that regulation, particularly standard-setting, discourages technological change.[76] The argument is that regulatory costs both reduce profitability needed to fund change and divert resources from other, presumably more productive research and development investments. Further, by increasing uncertainty and delaying the introduction of new products and processes, regulation discourages the innovative activity required of business.[77] This argument necessarily assumes both a fixed pool of resources available for innovation and diffusion of new technology, and a known and unitary set of outcomes available from the use of those resources. It is also argued that regulation falls more harshly on the smaller firms that are more likely to be innovators. The contrasting position, also argued by a well-established body of literature, sees a potentially positive effect of regulation. It argues that regulation can assist in motivating business to un-

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75. John R. Ehrenfeld, Technology and the Environment: A Map or a Mobius Strip, Background paper for World Resources Institute Symposium, Toward 2000: Environment, Technology and the New Century (June 13-15, 1990) (on file with author).

76. For a summary of the argument, see HENRY G. GRABOWSKI & JOHN MITCHAM VERNON, THE IMPACT OF REGULATION ON INDUSTRIAL INNOVATION 26-33 (Nat'l Acad. Sci., 1979); Rest & Ashford, *Formaldehyde, supra* note 33, at 71-72 ; Richard B. Stewart, *Economics, Environment, and the Limits of Legal Control*, 9 HARV. ENVTL. L. REV. 1, 2 (1985) [hereinafter Stewart, *Economics*]; Richard B. Stewart, *Regulation, Innovation, and Administrative Law: A Conceptual Framework*, 69 CAL. L. REV. 1259, 1279-81 (1981) [hereinafter Stewart, *Regulation*]. This argument does not always distinguish between regulation's impact on environmental technological change and more general technological change.

77. *But see* Rest & Ashford, *Formaldehyde, supra* note 33, at 75-78.

dertake innovation and diffusion of new technology, and in creating a market for new products, both by certifying them and creating their demand.[78]

There is case study evidence to support each position, and one overall, global conclusion appears impossible to determine.[79] This is not surprising; regulation and technological change are each diverse phenomena and their interactions only compound the diversity. This Article argues that regulatory standards sometimes inspire or require technological change, sometimes discourage it, and sometimes do both at the same time. The key inquiry is how to tailor regulation to promote and support environmental technological change.

These regulatory factors are not, of course, the only important ones for determining when change is likely and how it can be encouraged. Environmental technological change does not take place in a vacuum, but emerges from the total social, economic, technical and regulatory context.[80] The firm and industry factors interact with these regulatory factors, and any innovation-friendly policy must consider this interaction.[81]

This section will first consider the process of setting standards. It will then discuss the two different types of substantive standards, emissions limits and product regulations respectively. The importance of regulatory stringency will then be considered. Finally, the section will discuss possible ways to adapt the present system to make it more accommodating to pollution prevention and new technology.

B. *The Process of Setting Standards*

The process of standard setting discourages the technological change needed for pollution prevention in two general ways. First, the formality and delay of the standard-setting process

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78. For a short summary of this argument, see *id.* at 73-74.

79. A recent study of stakeholder attitudes concludes that the regulatory system is perceived as the greatest single barrier to creation and diffusion of new environmental technology. *See* ENVIRONMENTAL L. INST., ENVIRONMENTAL TECHNOLOGY VERIFICATION: A STUDY OF STAKEHOLDER ATTITUDES, ENVIRONMENTAL TECHNOLOGY CENTER 10 (July, 1995).

80. *See* Ashford & Heaton, *Chemical Industry*, *supra* note 3, at 155.

81. *See id.*

mean that individual standards are not likely to anticipate and effectively encourage particular technologies that are on the horizon but need developing. Second, the agency processes and the likely court challenge encourage companies to use their technical knowledge to seek more permissive standards, rather than to pursue prevention.

Agencies set standards with a hybrid quasi-legislative procedure known as "notice and comment" rulemaking.[82] The agency first conducts extensive informal discussions with interested parties to gather information. The first formal step — a notice of proposed rulemaking — follows. The notice describes the problem and the agency's current thinking about the proper solution. Important environmental rules have broad economic and social impact and they typically spark energetic participation in the process by many parties and interests. One or more quasi-legislative hearings are typically held at which parties present their views, and parties also offer extensive written comments. The notice, the hearings, and the written comments are all publicly available. The proposed rule may well undergo revision and further notice and comment. Eventually the agency issues the rule as the required environmental standard. Notice and comment rulemaking was originally planned to be an informal, speedy process designed to inform the agency's discretion and allow the agency to bring its expertise to bear on the problem.[83] However, this process has evolved quite substantially and it is now a lengthy and highly formalized one.[84]

In addition to the delay and formality of contemporary agency rulemaking, judicial review of agency rules has become the

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82. *See* Stewart, *Economics, supra* note 76, at 1273. For a general discussion of agency rulemaking processes, see RICHARD J. PIERCE ET AL., ADMINISTRATIVE LAW AND PROCESS § 6.4.6 (2d ed., 1992); BERNARD SCHWARTZ, ADMINISTRATIVE LAW §§ 4.10, 4.12-4.14 (3d ed., 1991).

83. *See* PIERCE ET AL., *supra* note 82, § 6.4.6.

84. "A recent study of rulemaking in the Environmental Protection Agency found that the average time that elapsed in rulemaking in the four major program areas -air, water, toxic substances, waste - ranged from slightly more than two years to just under five years." CORNELIUS M. KERWIN, RULEMAKING 107 (1994).

norm.[85] Usually this will involve business interests or environmental interests, or both, contesting the agency's action. The contest will typically present one or more of three basic claims. First is the claim that the agency violated one of the now formalized procedural rules applied to the administrative process.[86] Second, parties may well claim that the agency violated the substantive commands of its authorizing statute by setting either too restrictive or too permissive standards.[87] It is not unusual to have both claims made in the same proceeding, although, of course, by different parties with different interests.[88] Third is the claim that the agency's decision is so wrongheaded that it amounts to an abuse of discretion.[89] Full adversarial briefing and argument before a federal appellate court follows, with the ultimate decision being made by a legally sophisticated but technologically untrained judge.[90]

As a result of the formality of this entire rulemaking-judicial review process, and especially the time delays entailed, the process has only a limited ability to anticipate and support particular technological changes. Technological changes often work imperfectly at first, requiring an uncertain course of refinement in their development. Regulatory processes seek certainties that the prediction and implementation of future technological changes do not offer. The formalized and increasingly adversarial process in which parties respond to each other's presentations offer ideal opportunities for creating confusion, doubt, and delay, making any agency effort to anticipate change and force the technology even more vulnerable to challenge.

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85. "With one exception, every health standard issued by the Occupational Safety and Health Administration has been challenged in court, usually by both labor and management. The Environmental Protection Agency has estimated that some 80 percent of its rules stimulate lawsuits by dissatisfied parties." *Id.* at 116.

86. *See* Lead Indus. Ass'n v. EPA, 647 F.2d 1130, 1145 (D.C. Cir. 1980), *cert. denied*, 449 U.S. 1042 (1980).

87. *See id.*

88. *See id.*

89. *See id.* at 1145-46.

90. *See id.*

This process has a second unfortunate impact on technological change: it encourages a firm to use its knowledge of the business and its technological possibilities to seek more permissive standards, rather than to work on pollution prevention.[91] Prevention requires technological change, and those who operate the business will understand the possibilities for such change in their business better than an outside regulator ever can.[92] However, the formal process of standard setting offers the firm's personnel the opportunity to use their knowledge of these technological possibilities to argue for more permissive standards.[93] The adversary nature of this formal process often encourages such strategic use of information. Some firms, however, may wish to use environmental technical change as part of their competitive strategy. These firms are most likely to be either small, fringe firms in the industry, potential entrants, or outside suppliers of environmental equipment.[94]

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91. *See* Joseph F. Dimento & Francesco Bertolini, *Green Management and the Regulatory Process: For Mother Earth, Market Share and Modern Rule*, 9 TRANSNAT'L L. 121, 135 (1996); Peter C. Yeager, *Industrial Water Pollution*, 18 CRIME & JUST. 97, 109 (1993).

92. *See* Daniel J. Fiorino, *Toward a New System of Environmental Regulation: The Case for an Industry Sector Approach*, 26 ENVTL. L. 457, 464 (1996). While the company's knowledge of technological possibilities will almost certainly be better than anyone else's, this is not true of all the scientific issues presented. Standard-setting also requires an evaluation of the public health or ecosystem effects of a particular emissions discharge. Indeed, since such information is essential to the agency's core mission, one would expect that it would have developed a strong capacity for analyzing these issues.

93. There is, of course, no logical reason why the firm cannot use its information to pursue environmental technological change outside the regulatory process, although if it does so, the change may then be prominently featured in later proceedings to make the standards stricter. *Cf.* NATIONAL ADVISORY COUNCIL ENVTL. POL'Y & TECH. (NACEPT), EPA, IMPROVING TECHNOLOGY DIFFUSION FOR ENVIRONMENTAL PROTECTION 16 (EPA 130-R-92-001, 1992).

94. *See* Donald L. White, *Shaping Antitrust Enforcement: Greater Emphasis on Barriers to Entry*, 1989 BYU L. REV. 823, 833 (1989).

C. *Emission and Discharge Limits*

1. Regulatory Impacts on Technological Change

Controls on pollution, specifically emission and discharge limits, protect the environment by directly controlling the release of wastes. These limits are usually set either with reference to limiting exposure to protect public health, or with reference to what is technically possible. For example, the Clean Air Act mandates health-based standards for air emissions limits.[95] Such health-based standards have a great theoretical potential to force the development and adoption of new technology by mandating specific environmental protection results.[96] Technology-based standards, such as those for the discharge of water pollutants, are often contrasted with health-based standards.[97] When standards are set with reference to what is technologically possible, they have the theoretical potential to mandate widespread diffusion of existing technology; if they were revised as better technology became available, they could encourage technology development.[98]

Sadly, the standards actually set have only had modest requirements for technological change. Both health-based standards and technology-based standards tend to be set with reference to costs and available cleanup technology.[99] There also is evidence and

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95. Primary ambient air standards are to be set at a level "requisite to protect the public health." 42 U.S.C. § 7409(b)(1) (1994). Secondary standards are to be set at the level necessary to protect the public welfare. *See id.* § 7409(b)(2).

96. *See* D. Bruce La Pierre, *Technology-Forcing and Federal Environmental Protection Statutes*, 62 IOWA L. REV. 771, 774 (1977).

97. Under the Clean Water Act, discharge of conventional pollutants is to be limited to "the degree of effluent reduction attainable through the application of the best practicable control technology currently available" and the standards are to be based on consideration of the costs of the technology, the benefits of reduction, and "the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques . . . ." 33 U.S.C. § 1314 (b)(1)(A), (B) (1994). For toxic discharges, the limits are to be limited to that attainable with the "best available technology economically achievable." *Id.* § 1311(b)(2)(A).

98. *See, e.g.*, La Pierre, *supra* note 96, at 773-74.

99. Professor La Pierre found that:

[i]n the case of existing stationary sources of air pollutants,

widespread opinion that standards in fact tend to require only a lowest common denominator of existing technology, and that they do not typically force real innovation.[100] Pollution control regulations often require only the technological status quo. This doubtless reflects the lengthy and adversarial process for setting them, discussed above. In addition, the need to set so many standards leads to an enormous agency workload, with stagnant agency resources, making technologically conservative results an "easy way out."[101] Of course, if these technologically undemanding standards were regularly updated, they would still create an anticipated market opportunity for innovators and continuing pressure for diffusion of better technology. However, the process of standard setting is in reality so arduous and time-consuming that, once set, standards tend not to be revisited frequently.[102] Logically, the resulting technology-oriented standards should lead to substantial diffusion of known technology, but one would expect little innovation. By reinforcing the status quo, these technology-based standards have the potential to retard future inno-

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> hazardous air pollutants, motor vehicle air pollutants, and toxic water pollutants [all subject to health-based standards at that time], the EPA and the courts have retreated from the mandate of a health-based standard that pollution must be reduced to a level that protects public health regardless of cost and technological feasibility. They have, in effect, converted the health-based standards into technology-based standards.

Id. at 837.

100. *See id.* at 837-38. While noting the valuable service in the Clean Water Act's regulatory regime that has set "bomb-proof, minimum-at-least level technology requirements," Professor Houck concludes: "It is also clear, however, that the standards in many industrial categories reflect a compromise far short of 'best available technology,' even the best available at the time they were promulgated, to say nothing of subsequent developments in source reduction and reuse." Oliver Houck, *The Regulation of Toxic Pollutants Under the Clean Water Act*, 21 ENVTL. L. REP. 10,528, 10,538 (1991); *see* Stewart, *Regulation*, *supra* note 76, at 1296.

101. Heaton, Regulation and Technological Change, *supra* note 17, at 22.

102. *See id.* at 7.

vation.[103] Frequently, by the time standards are adopted, many businesses are already in compliance and the standards create little incentive to go further.[104]

How has business actually responded to these often technologically undemanding standards? While many opinions are offered, as surveyed above, there is only limited evidence, all of it in the form of individual case studies. The studies are of a diverse group of industries and regulations and the business responses have been varied. As one would expect, diffusion of existing technology is more common than innovation, and responses that involve little or no technological change are also frequent. Much of the variety in response is consistent with the theory that technologically fluid industries are likely to change more frequently and radically than technologically mature ones. However, firm and industry-specific factors are also important, and some of the variation is beyond the explanatory power of current theory. The responses of several specific industries to environmental regulation illustrate this.

The diverse responses to new regulations on the discharge of sulfur dioxide illustrate the importance of a particular industry's technological maturity.[105] The dominant firms in the smelting business first challenged the rules in court and then installed available pollution control devices.[106] This diffusion of existing technology is what one would expect from dominant firms in this technologically rigid sector. However, copper mining firms developed a new, cleaner process to assist their entry into the smelting business — a predictable innovative response by outsiders wanting to enter.[107] While other business conditions also fa-

103. *See* Stewart, *Economics, supra* note 76, at 9 (referring to the present system as "litigation based central planning" that has promoted adoption of available and affordable technology "at inordinate expense," but has not created incentives for further improvement).

104. The evidence is collected in Ashford & Heaton, *Chemical Industry, supra* note 3, at 136. To some degree, this may reflect anticipation of the new standards, such as in the case of PCBs. *See* Ashford et al., *Using Regulation, supra* note 3, at 426.

105. *See* Heaton, Regulation and Technological Change, *supra* note 17, at 16.

106. *See id.*

107. *See id.*

vored the entry opportunity, the emissions regulation clearly provided reinforcement for such entry and ultimately promoted environmental technological innovation.[108]

When new air pollution and OSHA standards were adopted for vinyl chloride, both innovation and diffusion resulted from this technologically fluid industry and its suppliers.[109] The 1976 Clean Air Act regulations were strict and many initially questioned their technological feasibility.[110] However, this was a fluid industrial segment with flexible technology, and accordingly its responses were innovative: accelerating their incremental process innovations to reduce exposure from resin handling and cleanup.[111] The industry also used diffusion of existing technology, mostly to improve monitoring and reduce leakage.

In addition to the Clean Air Act regulations, OSHA regulations issued in 1974 controlled workers' exposure to vinyl chloride.[112] Vinyl chloride manufacturers were able to comply with this standard without innovating, by tightening valves and fixing leaks, while PVC plastics manufacturers adopted improved ventilation and incremental process innovations.[113] However, the manufacturers' suppliers provided the innovation that soon became the primary solution: "As suppliers responding to the OSHA regulation, they removed most of the RVCM [the harmful residual of the vinyl chloride manufacturing process] before delivering the PVC resins to the fabricators."[114] Again, the outsiders were the most innovative, ultimately changing their product.

However, this theory fits less well with the diverse responses to

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108. *See id.*

109. This example is taken from Ashford et al., *Using Regulation*, *supra* note 3, at 440-41.

110. *See id.* at 440.

111. *See id.* at 441.

112. *See* Occupational Safety and Health Standards, Subpart Z-Toxic and Hazardous Substances, 29 C.F.R. § 1910.1017(c) (1996). These are analogous to health-based emissions standards as they set exposure limits with respect to health implications. In general, " 'Hazardous substance' means any operation, procedure, or activity where a release . . . would result in an employee exposure in excess of the permissible exposure limit." 29 C.F.R. § 1910.1017(b)(7) (1996).

113. *See* Ashford et al., *Using Regulation*, *supra* note 3, at 440-41.

114. *Id.* at 441.

new OSHA regulation of occupational exposure to lead.[115] All of the three industry segments involved — primary smelting, secondary smelting, and battery manufacture — responded with diffusion of existing technology to reduce worker contact.[116] The technologically fluid battery making industry went further and also introduced radical product and process innovation, as the theory would predict it might.[117] However, the theory would not have predicted the introduction of two process innovations in the technologically mature secondary smelting industry. The leading commentary claims this was a victory for environmental regulation motivating real technological change in a place where it was otherwise unlikely.[118] However, there is no specific support for inferring causation from this correlation.

When EPA established effluent and emissions limits for mercury discharges in chloralkali plants, industry responses covered the entire spectrum of technological possibilities.[119] The water effluent standards adopted in 1972 limit the effluent discharges per amount of product per day.[120] One industry response to these standards was to dig up sewer pipes to clean and replace as necessary — a non-innovative effort.[121] However, there was also substantial innovation. The industry began separating cooling water so it did not come into contact with the mercury: "a significant process innovation by the regulated industry."[122]

There was also a fair amount of diffusion. The industry used a known treatment process, sulfide precipitation, to remove most of the mercury — an example of diffusion of known cleanup technology.[123] New Clean Air Act regulations in 1977 brought

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115. *See* 29 C.F.R. § 1910.1025(c) (1996). This example is taken from Ashford et al., *Using Regulation, supra* note 3, at 438-40.

116. *See* Ashford et al., *Using Regulation, supra* note 3, at 439.

117. *See id.* (describing the changes).

118. "Here, technology-forcing regulation dramatically revitalized the innovative potential of a rigid, mature industry." *Id.*

119. *See id.* at 437-38.

120. *See* EPA, Effluent Guidelines and Standards for Inorganic Chemicals, 40 C.F.R. § 415.62(a) (1996). New plants standards are found in 40 C.F.R. § 415.65(a) (1996).

121. *See* Ashford et al., *Using Regulation, supra* note 3, at 437.

122. *See id.*

123. *See id.*

forth more diffusion of existing pollution control devices to remove mercury mist and vapor in the gas stream.[124] The latter example shows the variety of responses possible within one industry, as well as the limitations of our understanding of their causes.

OSHA's regulation of cotton dust exposure both furthered regulatory goals (here reduced worker exposure) and supported industry efforts to modernize and improve productivity — the happiest of business and regulatory outcomes.[125] However, this regulation did so primarily because of non-regulatory pressures on the industry that coincided with the response to regulatory commands.[126] The industry was modernizing in response to substantial competitive pressure and the newer machinery both reinforced the need for cleaner workplaces and made them possible.[127]

> That modernization and the associated compliance with the OSHA standard were accomplished not by radical or even incremental innovation, but by the broad diffusion of existing textile technology, most of which was developed in the 1960's. . . . The relationship between the new technology and the cotton dust emissions was crucially interactive. On the one hand, the new equipment produced much less cotton dust; on the other, the new equipment was more sophisticated and highly sensitive to dust. Modernization in textile technology both required and caused reduced cotton dust emissions. . . . Commentators have convincingly argued that the U.S. textile industry has derived a net benefit from the OSHA cotton dust regulation.[128]

Automobiles offer a useful, if mixed, example of emissions regulations leading to technology forcing.[129] Strict emissions controls

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124. The regulations are at 40 C.F.R. § 61.52 (1996). *See* Ashford et al., *Using Regulation, supra* note 3, at 437-38.

125. *See* Ashford et al., *Using Regulation, supra* note 3, at 442.

126. *See id.*

127. *See id.*

128. *Id.* See SAROKIN ET AL., *supra* note 45, at 114, for a similar example in which air emissions regulations prompted the adoption of floating roofs for chemical tanks; they worked so well that the company installed them at all its plants, even when not subject to a regulatory requirement to do so.

129. *See* Heaton, Regulation and Technological Change, *supra* note 17, at 18-19.

prompted diffusion of a known technology (catalytic converters), which itself required substantial adaptation and development.[130] This and other incremental developments have led to quite dramatic progress in lowering the automobile emissions per mile driven. However, there has been only very limited development of technological alternatives to the traditional internal combustion engine and "it also seems fair to say that the most far-reaching changes . . . were pioneered by foreign firms, and that much of the ultimately successful compliance technology (e.g., catalytic converters) was developed by suppliers."[131]

At a minimum, these examples show that regulation does not invariably discourage new technology, and they suggest that it need not discourage it at all. Innovation and diffusion of new technology sometimes result from environmental emissions and discharge limits. The key for regulators is to understand why this happens, and when it is likely, in order to support and encourage it more effectively. The fluidity or rigidity of the industry's core technology is clearly an important factor. Industry specific factors, such as the need for modernization and the availability of technology to do it, as with cotton dust, are also important. Suppliers and adjacent industries may supply much of the change, particularly the innovation that can offer the most dramatic gains in an established industry with mature technology. Strict regulations can spark substantial diffusion and even innovation, even in mature, rigid industries, although they will not invariably do so. Technological change, whether innovation or diffusion, or both, is responsive to firm, industry, and regulatory factors, and sophisticated regulators must take them into account.

2. Stricter Standards for New Sources

Emission control schemes virtually always impose stricter limits on new sources than on existing ones.[132] The rationale for this approach is straightforward and appealing.[133] For environmental

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130. *See id.*

131. *Id.* at 19.

132. *See, e.g.*, Clean Water Act (CWA), 33 U.S.C. § 306; Clean Air Act (CAA), 42 U.S.C. § 7411; *see also* Stewart, *Regulation, supra* note 76, at 1314-15.

133. *See* Stewart, *Economics, supra* note 76, at 5.

The "available and affordable technology" approach has re-

regulatory purposes, a new source can be either a new plant or new equipment, or it can be a process change in an existing facility that changes the waste stream. In either situation, the change may be motivated by many business factors, with environmental performance likely to be no more than one of many on the list, and perhaps not even a prominent one. When a new plant or new equipment is utilized, each should incorporate the latest in design and process technology, which is quite likely to be cleaner than older ones. Further, because reduced emissions can be designed in, rather than added on, reductions should be both cheaper and easier to achieve in a new source.

In contrast, process changes will not necessarily be made to achieve better environmental performance, as they may be motivated by a variety of business influences, so they should be required to do so. From a broad policy perspective, today's concern with environmental protection requires that plant, equipment, and process changes that lead to new source review should not be made if they cannot be made cleaner than the old ones.

More restrictive standards for new sources also reflect the political realities of getting any environmental regulatory regime established. If the strictest standards were applied to old sources, the costs, disruptions, and threat of plant closings would be quite substantial.[134] These would almost certainly lead to political pressures that could result in either watering down the general stan-

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> sulted in much more stringent standards for new plants and products. This differential reflects in part the fact that it is cheaper to build pollution-minimizing processes or controls into new facilities and products rather than retrofit old ones. But it also reflects the fact that stringent new plant and product controls will not cause shutdowns. The pattern of much more stringent controls in new processes and products also reflects common interests among environmentalists and existing industry. Environmentalists argue that best available technology should be built into new plants and products in order to minimize increased pollution. Existing industry enjoys a competitive advantage when new competitors are subject to more stringent controls.

Id.

134. *See* Stewart, *Regulation*, *supra* note 76, at 1314.

dards to the level that old sources would find economically and technologically — hence politically — acceptable, or possibly preventing adoption of the whole regulatory scheme. In addition, because new source standards are uniform across the nation, they also discourage the relocation of pollution sources from "dirty" to "clean" areas to take advantage of less strict requirements.[135] Finally, as a practical matter, new sources must get permits and monitor compliance under more robust and mature regulatory systems that presumably do a better job of ensuring compliance than the nascent regulatory systems that first controlled the older sources.[136] The result is stricter application of stricter standards to new sources.

These are important justifications. Stricter standards for new sources can mandate the diffusion of new technology. However, they can also have the unfortunate side effect of discouraging pollution prevention's technological change.[137] Environmental technological change can often cause some change in the waste stream; if these changes are large enough, they will trigger the requirement of new permits under the tighter new source standards.[138] In the worst such case, this might lead to a slight in-

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135. *See id.*

136. *See id.* at 1314-15.

137. *See id.*; Heaton, Regulation and Technological Change, *supra* note 17, at 21.

138. Under the CAA ambient standard, the term "new source" includes modification of a stationary source. 42 U.S.C. § 7411(a)(2) (1994). "The term 'modification' means any physical change in . . . a stationary source which increases the amount of any air pollutant emitted by such source or which results in the emission of any air pollutant not previously emitted." 42 U.S.C. § 7411(a)(4) (1994). For hazardous air pollutants "modification" means "any physical change in . . . a major source which increases the actual emissions of any hazardous air pollutant emitted by such source by more than a de minimis amount or which results in the emission of any hazardous air pollutant not previously emitted . . . ." *Id.* § 7412(a)(5).

Under the CWA, new sources are those constructed after the publication of proposed applicable regulation. "The term 'construction' means any placement, assembly or installation of facilities or equipment . . . ." 33 U.S.C. §§ 1316 (a)(2), (5) (1995).

As discussed *infra* Part IV.A, in-plant re-use, recycling or reprocessing of waste materials may trigger quite demanding RCRA permitting crease in one waste stream, putting it in violation of the new source standards, even if it also leads to a much greater reduction in other waste streams and to a net environmental benefit. In general, if pollution prevention projects are new sources, with stricter standards, their environmental permits will be more difficult to obtain and to comply with, despite their net environmental benefit.

Stricter standards for new sources may also discourage development of environmental technology innovations, especially from outsiders who wish to sell them to the existing firms in the industry. Such a technology developer must anticipate the need to meet the stricter new source standards, and to demonstrate that it does so to many different state regulators, in order to sell the new technology.

The difficulty with this scenario is clear when one considers how innovation generally occurs. It is frequently an incremental process in which the first effort may not be completely successful and further refinement and development must be anticipated.[139] Stricter new source requirements particularly burden this process by delaying permits for new technology until after all the refinement and development are complete, to some degree discouraging the sale of the new technology.[140]

Given the substantial policy and political justifications for stricter new source emissions requirements, these will surely remain a central part of the regulatory system. The present statutes clearly mandate stricter new source standards, and there is little agency discretion to do otherwise.[141] While these standards can require diffusion of new technology, they can also discourage innovation and diffusion by requiring the new technology to comply with a stricter standard. These problems must be addressed

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requirements and many business sources report that this discourages these activities.

139. *See supra* Part II. There have been several studies of the impacts of regulatory delay and uncertainty on the profitability of investments in innovation and these are surveyed and critiqued in Ashford & Heaton, *Chemical Industry*, *supra* note 3, at 128-29.

140. Many of these same concerns arise with stricter standards for new products, and these are discussed *infra* Part III.D.

141. *See* 42 U.S.C. § 7409 (1996).

as part of creating a more technology friendly regulatory system.[142]

D. *Product Regulations and Technological Change*

In contrast to the regulation of emissions discussed above, several environmental regulatory schemes control the sale of individual products and substances. This section will examine the regulation of the sale of pesticides under FIFRA,[143] and control over the sale of toxic substances under TOSCA.[144] The impact of pharmaceuticals regulation on innovation will also be considered where it offers insight.

While the details vary, the regulatory schemes under FIFRA and TOSCA share two fundamental features in controlling market access of specific products. First, both balance protection of the public health against the social and economic utility of the regulated products. Second, these schemes usually impose stricter standards for new products than for existing products, notwithstanding possible reevaluations of the latter in the future.

1. Regulation of Existing Products

Both FIFRA and TOSCA require registration before certain products can be sold. EPA can impose restrictions on the use and sale of products if they are deemed to pose "unreasonable" risks to the environment.[145] EPA can also restrict or withdraw re-

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142. These are considered among the available policy alternatives *infra* Part III.F.

143. Federal Insecticide, Fungicide, and Rodenticide Act § 13(a), 7 U.S.C. § 136k (as amended, Oct. 25, 1988). For a general survey, see Cynthia A. Lewis, *Pesticides*, *in* 3 LAW OF ENVIRONMENTAL PROTECTION 17-1 (Sheldon M. Novick et al. eds., 1997) [hereinafter L. ENVTL. PROTECTION].

144. Toxic Substances Control Act § 2(b), 15 U.S.C.A. § 2601(b) (as amended Oct. 28, 1992). For a general survey see Ronald B. Outen et al., *Toxic Chemicals*, *in* 3 L. ENVTL. PROTECTION, *supra* note 143, at 15-1.

145. FIFRA specifies no "unreasonable adverse effects on the environment," 7 U.S.C. § 136a(c)(3)(B)(I)(I), (5)(C)-(D) (1994), and defines these to mean "any unreasonable risk to man or the environment . . . ." *Id.* § 136(bb)(2).

gistration.[146] Existing chemical products were grandfathered into registration when the statutes were enacted, subject to revocation upon a later finding that the statutory standard was not met.[147] As a result, a very large number of products and chemicals were registered, and because of backlogs in the testing process, most have never been subject to any careful review.

The backlog problem is particularly acute with TOSCA. When the statute was enacted in 1979, there were approximately 62,000 chemicals registered, approximately two percent of which had been carefully reviewed for risk.[148] Although EPA has listed 16,000 of these as priority items for review, only about 100 are reviewed each year and only about ten percent of those receive any regulatory action.[149] Negotiated testing or controls are the norm. Of the ten percent carefully considered (comprising 2,431 chemicals), four have been directly regulated, consent orders specifying voluntary restrictions were entered on 626, manufacturers voluntarily agreed to perform toxicity tests on 827, and the chemical was withdrawn in 974 cases when EPA indicated an intent to require testing or controls.[150] A statutory provision and schedule was set up to take care of the FIFRA backlog of 600

TOSCA uses the basic statutory standard of "unreasonable risk of injury to health or the environment." 15 U.S.C. § 2601(a)(2), (b)(3) (1994). TOSCA also directly expresses a concern with its impact on new technology: "It is the policy of the United States that . . . (3) authority over chemical substances and mixtures should be exercised in such manner as not to impede unduly or create unnecessary economic barriers to technological innovation . . . ." *Id.* § 2605(b).

The systems are different on the requirement of advance testing of products prior to registration. FIFRA requires the manufacturer to conduct preliminary tests to determine safety, *see* 7 U.S.C. 136a(c)(1)(F); TOSCA places the initial responsibility for determining if tests are needed on EPA, *see* 15 U.S.C. § 2603(a).

146. For FIFRA suspension and cancellation procedures, see 7 U.S.C. § 136d(b), (c)(1); for TOSCA, see 15 U.S.C. § 2603.

147. *See, e.g.*, FIFRA, 7 U.S.C. § 136a(c)(7); TOSCA, 15 U.S.C. §§ 2603(c), 2604(h).

148. *See* GENERAL ACCT. OFF., TOXIC SUBSTANCES CONTROL ACT: LEGISLATIVE CHANGES COULD MAKE THE ACT MORE EFFECTIVE 2-3 (GAO-RCED-94-103, 1994).

149. *See id.* at 4, 16.

150. *See id.* at 16.

identified substances.[151]

There has been little evaluation of the impact on technological change of the ongoing regulation of existing products under these statutes. Specific instances of a product or chemical being deregistered have been too rare to occasion empirical or case studies. Generally, deregistration requires EPA to establish some type of prima facie case of excessive risk before the burden shifts to the company to establish a favorable risk-benefit calculus.[152] The vast numbers of products and chemicals involved, together with the information required to make the necessary showing, mean that EPA action will be slow.[153] In this situation, it seems unlikely that there is any meaningful impact on technological change, but there is no evidence either way.

In contrast, bans on existing products do tend to provoke technological changes, and these have been carefully studied.[154] While virtually all product bans have affected only mature industry sectors, the technological responses have varied widely. The response of the industry manufacturing the banned product has typically involved only limited innovation, although not invariably so. When PCBs were banned, the only U.S. manufacturer, Monsanto, voluntarily restricted sales and then exited the market.[155] However, when EPA banned phenyl mercury from oil-based paint and lead from all paint, the paint industry responded by substituting other known compounds, or increasing the levels of

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151. *See* Lewis, *Pesticides, supra* note 143, at 17-15 to 17-17.

152. *See, e.g.*, National Coalition Against the Misuse of Pesticides v. EPA, 867 F.2d 636, 642 (D.C. Cir. 1989); Environmental Defense Fund, Inc. v. EPA, 548 F.2d 998, 1005 (D.C. Cir. 1976) (applying 7 U.S.C. § 136d).

153. *See* Donald T. Hornstein, *Lessons from Federal Pesticide Regulation on the Paradigms and Politics of Environmental Law Reform*, 10 YALE J. ON REG. 369 (1993) (arguing that EPA reliance on pesticide manufacturers to produce scientific data allows manipulation and delay of the risk assessment procedure). "In short, the risk assessment enterprise is so information intensive that it creates strategic incentives to avoid a serious scientific examination of 'true' levels of public health and environmental risk . . . . [T]he informational demands of risk analysis doom the regulatory process to a perpetual state of slow motion." *Id.* at 437.

154. *See* Ashford et al., *Using Regulation, supra* note 3, at 432-33.

155. *See id.*

specific additives.[156] This diffusion of substitutes was not particularly innovative, but the availability of substitutes perhaps meant that a more innovative response was not needed. When lead was banned from gasoline, the oil refining industry eventually responded by developing new catalysts for its refining process — a successful incremental innovation — that met environmental objectives and also made the refining process cheaper and more efficient.[157]

In contrast, the responses of outsider firms to product bans are invariably technologically innovative. In the case of PCBs, while Monsanto, the only current domestic supplier, chose to exit the market,[158] Dow Corning and General Electric developed new substitute products and used them to enter the market.[159] In response to the ban on CFCs, American Cyanamid, a chemical company that had not been in the CFC market, developed a substitute aerosol propellant, while other outsiders developed a pump that did not require any propellants at all.[160]

Product bans are politically difficult because they typically provoke vigorous objection from the current makers and sellers of the product.[161] In addition, technological responses — successful or not — entail significant costs and disruption to the affected firms.[162] Further, the reported evidence may well be biased; many more successful case studies are reported than unsuccessful ones, doubtless reflecting an understandable business tendency not to publicize failures.[163] Finally, a ban directed against an emerging technology might serve to more deeply entrench an existing one, whatever its own environmental merits. Despite these qualifications, however, the overall record is favorable. Bans on existing

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156. *See id.* at 434-35.

157. *See id.* at 436-37. This was the oil companies' second response; the first was the substitution of another known additive. However, this proved unacceptable because it interfered with the working of catalytic converters. *See id.* at 436.

158. *See* Ashford et al., *Using Regulation, supra* note 3, at 432-33.

159. *See id.* at 433; Ashford & Heaton, *Chemical Industry, supra* note 3, at 124.

160. *See* Ashford et al., *Using Regulation, supra* note 3, at 433-34.

161. *See* Hornstein, *supra* note 153, at 434-35.

162. *See id.*

163. *See id.* at 436.

products have frequently induced technological change resulting in environmentally preferable substitutes.

2. Regulation of New Products

New product regulation typically requires that producers submit new products for approval before they can be sold. Pesticides, toxic substances and pharmaceuticals are the best-studied examples. Although new product regulations are made under the same statutory criteria that are applied to existing products, the actual process effectively sets a higher standard for new products.[164] With new products, the burden of producing information and persuading regulators is squarely on the manufacturer.[165] In addition, the manufacturer must provide actual proof that new products satisfy the statutory standard, even though most of the older products they replace were likely grandfathered and may have never been subject to the same scrutiny. This discrepancy is problematic, as new products often embody technological changes that support environmental protection:

> In recent years, actions by the EPA have delivered almost universally negative messages -new chemicals are being assessed with increasing skepticism, old chemicals are rarely regulated aggressively, and new products involving genetic engineering have become mired in poorly defined regulatory procedures and uncertain science.
>
> The pesticide regulatory program is largely reactive. Opportunities for regulation to reinforce positive technological change are neither sought nor considered important.
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> . . .
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> This practical reality is unfortunate because the scientific capacity clearly exists within the agrichemical industry to move quickly toward commercialization of a new generation of improved pest control technologies.[166]

There is much evidence of regulation's chilling effect on new

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164. *See* Stewart, *Regulation, supra* note 76; *see also supra* text accompanying note 76.

165. Under TOSCA, EPA must make threshold determinations of the need for testing before extensive testing is required; in practice, the requirement of testing is often negotiated with the manufacturers. *See* GAO, TOXIC SUBSTANCES CONTROL ACT, *supra* note 148, at 16.

166. *See* Ashford & Heaton, *Chemical Industry, supra* note 3, at 123.

product development, but few easy answers.[167] A surge in the number of new chemicals preceded adoption of TOSCA, which was in turn followed by a short-term decline.[168] This decline may have only reflected the surge having coincidentally cleared the pipeline. In the pharmaceutical industry, one early study concluded that regulation led to a slowdown in the rate of new drug introductions.[169] Later research has shown serious methodological flaws in this work, establishing that the way regulation affected new drug development was a complex matter, influenced most strongly by the therapeutic class of the drug.[170]

Some studies have clearly shown discouraging effects on new products, however. There is substantial evidence that regulation increases the costs of pharmaceutical research and development.[171] Evidence also suggests that the pre-approval requirement for toxic substances has a similar effect on the chemical industry.[172] The greatest concern in both of these industries is that these effects fall most heavily on smaller firms which have traditionally provided a disproportionate share of the industry's innovation. Smaller companies have far narrower flexibility in amortizing the costs of testing and delay. Also, there may be other economies of scale in maintaining the expertise necessary to comply with the regulatory system, as well as in the ability to in-

167. *See* Heaton, Regulation and Technological Change, *supra* note 17, at 13-17.

168. For a careful review of the literature, see Ashford & Heaton, *Chemical Industry, supra* note 3, at 146-52. *See also* AMERICAN CHEM. SOC'Y, FEDERAL REGULATION AND CHEMICAL INNOVATION, (C. Hill ed., 1979); Wesley A. Magat, *The Effects of Environmental Regulation on Innovation,* 43 L. & CONTEMP. PROBS. 4 (1979).

169. *See* Sam Peltzman, *An Evaluation of Consumer Protection Legislation: The 1962 Drug Amendments,* 81 J. POL. ECON. 1067 (1973).

170. *See generally* D. HATTIS, MIT, RELATIONSHIPS BETWEEN PHARMACEUTICAL REGULATIONS, INNOVATION AND THERAPEUTIC BENEFITS (1985); EMERY LINK & SAMUEL A. MITCHELL, IMPACT OF PUBLIC POLICY ON DRUG INNOVATION AND PRICING (1976).

171. *See generally* LINK & MITCHELL, *supra* note 170.

172. *See* Ashford & Heaton, *Chemical Industry, supra* note 3, at 153-54. EPA estimates for it to determine that more testing is needed for a new chemical, it takes 24 to 30 months and costs from $68,500 to $243,000. These costs do not include the costs of then conducting the tests required. *See id.*

fluence it.[173]

However, these regulatory systems may also enhance new products by requiring a more intense development process:

> Studies from both the pharmaceutical and TOSCA areas indicate that the testing and analysis which is now routinely undertaken in the development of the application for government approval often also yields a much better idea of the characteristics of the product under development. In addition, a variety of studies have shown that regulation-related R & D often suggests new uses for products and sometimes new product lines. It appears that these benefits are most likely to occur among companies with significant research establishments where these costs can be absorbed relatively easily, where speed in new product introduction may not be critical to capturing a market, or where the regulatory constraint has promoted new, creative thinking.[174]

While the impact of new product regulations on technological change is important, new product regulations surely offer society greater assurance that new products are safer and more effective.

Conclusions on the effects of all product regulations are difficult. Although there are individual exceptions, as a group existing products are not subject to robust scrutiny by the day-to-day regulatory system, and there is little basis for expecting much of an impact. Product bans of existing products, when used, have been effective in provoking environmentally beneficial technological change although the source and type is quite varied and some failed efforts must be expected. New product regulation raises concern about entrenching existing technology and discouraging the most innovative segments of the industry, but regulation may also support the marketplace success of new products that are approved.

E. *Regulatory Stringency and Technological Change*

With both emissions limits and product regulations, more stringent standards support the technological change that leads to prevention as well as control.[175] In general, a standard is more

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173. *See* Ashford & Heaton, *Chemical Industry, supra* note 3, at 153.

174. *Id.* at 154.

175. The concern here is with the requirements expressed in the standards as written; related issues of the strictness and certainty of enforcement of those standards are discussed *infra* Part V.

stringent if it is more demanding in any of three respects: first, if it requires a significant reduction in discharge or exposure to harmful substances; second, if compliance using existing technology is especially costly; and third, if the regulation requires a significant technological change.[176]

Certainly, banning an existing product is the most stringent regulation and, as discussed above, product bans have invariably led to technological change.[177] Prohibiting or severely limiting emissions, as in the cases of vinyl chloride and cotton dust, is also associated with technological change. For outsiders, bans or severe limits offer a changed business situation that can create or enhance entry opportunities. For insiders, bans or severe limits may threaten the firm's continued participation in the market, thus sparking innovation or diffusion. Of course, such pressure can also generate a political backlash aimed at changing the statute or weakening the agency's standards.[178]

The two Inform studies of waste reduction in the chemical industry considered firms' motivations for specific waste reduction activities.[179] Both studies support the idea that stringent regulation is more likely to induce technological change.[180] The first study, in 1985, found that management generally did not voluntarily embrace waste minimization efforts.[181] More typically, waste minimization was forced upon management by rising waste disposal costs and increasing difficulty of disposal.[182] However, the 1992 study found that direct environmental regulatory controls over waste disposal were much more frequently offered as a reason for waste minimization efforts: "Environmental regulations have been the fastest growing incentive in recent years, cited as

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176. *See* Ashford et al., *Using Regulation, supra* note 3, at 426.

177. *See* Ashford & Heaton, *Chemical Industry, supra* note 3, at 154-55.

178. *See* Heaton, Regulation and Technological Change, *supra* note 17, at 9.

179. *See* DORFMAN ET AL., *supra* note 45; SAROKIN ET AL., *supra* note 45.

180. *See* DORFMAN ET AL., *supra* note 45; SAROKIN ET AL., *supra* note 45.

181. *See* SAROKIN ET AL., *supra* note 45, at 31-34.

182. Liability fears, public scrutiny, and operational constraints were also important considerations. *See id.*

the reason for 40 source reduction activities implemented between 1985 and 1990, as opposed to 10 activities implemented before 1985 — a 300% increase."[183] Thus, even in 1992 with the much-proclaimed new environmental consciousness of business, most source reductions in these plants were the result of waste disposal costs and environmental regulation.

While a regulatory process must allow for the risk, delay, and uncertainty inherent in the diffusion of existing technology, this is even more true for more fundamental innovation of new technology or managerial ideas.[184] Real innovations offer greater potential environmental benefits, but they are typically more difficult; they cost more, present more business and technical risks, and take longer to conceive and implement. As a result, the regulatory process can inadvertently discourage this extra effort if it does not anticipate and allow for the new technology's special demands. While the permitting, compliance and enforcement processes must respond vigorously, regulatory standards must be drafted with some flexibility in order to give the process of technological change its needed incubation period and breathing room.[185] The regulations should authorize longer lead times, innovative test efforts, and "fail soft" strategies in the development of new technologies.

F. *Policy Approaches to Promote Technological Change in Standard Setting*

To promote technological change, environmental standards must promote responsive business decision-making in order to insure that business will embrace technological change needed to prevent pollution rather than just control it at the end-of-the-pipe. Three main arguments will be discussed in this subsection. First, standards that regulate across all environmental media would promote prevention and technological change more effectively than the current single-medium standards. Second, such standards can be set to directly promote and support needed

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183. *See* DORFMAN ET AL., *supra* note 45, at 45-46.

184. *See* Strasser, *supra* note 2, at 7-15.

185. *See* EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93, at 49; Ashford, *Technological Responses*, *supra* note 17, at 292.

types of change and to target the most likely actors. Third, standards promoting technological change must allow for the uncertainty and delay inherent in the process.

Common themes run throughout these discussions. A technology-oriented policy must consider firm-specific and industry-specific factors if the policy is to be effective. It is at the individual firm and industry levels that innovation and diffusion opportunities are either embraced or discarded. Thus, sophisticated regulators will require a deep familiarity with the specifics of individual industries and firms to anticipate and support technological change in them. Ultimately, this will also require new training and technical support for regulatory personnel.[186]

1. Multimedia Standards

Comprehensive regulation of a facility's total environmental impact has been often discussed, but only rarely implemented.[187] Multimedia compliance and enforcement is now receiving serious attention from regulators, but multimedia standard-setting faces significant obstacles.[188]

This is unfortunate, because multimedia standards could potentially encourage necessary changes in business thinking. A multimedia standard could, for example, limit the total discharge of a pollutant — dioxin, for example — from a particular facility. Removing or reducing a pollutant from all waste streams would necessitate the joint consideration of product, process, and raw materials changes.[189] Multimedia standards direct attention to the decisions that cause the pollution in the first place, rather than

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186. *See* EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93, at 85.

187. This article will not review this history in general; for a survey see Fontaine, *supra* note 6, at 36-37. For an excellent discussion, see Lakshman Guruswamy, *Integrating Thought ways: Re-Opening of the Environmental Mind?*, 1989 WIS. L. REV. 4631. Citations to the literature are collected in Lakshman Guruswamy, *Integrated Environmental Control: The Expanding Matrix*, 22 ENVTL. L. 77, 80 n.9 (1992). *See generally Integrated Pollution Control: A Symposium*, 22 ENVTL. L. 1 (1992).

188. *See* EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93, at 85.

189. *See* Strasser, *supra* note 2, at 36.

to the end-of-the-pipe or smokestack where the discharge takes place. By encouraging this internal focus, such standards can support prevention.

Single medium standards and their enforcement tend to shift pollutants around, often to less strictly regulated media.[190] Multimedia standards can encourage business to eliminate pollutants rather than shift them around to less regulated media:

> In power plants, for example, sulfur dioxide emissions from the burning of high-sulfur coal are often reduced by the use of wet flue gas scrubbers. However, these scrubbers generate solid wastes that must be landfilled and effluent discharges that must undergo treatment. A multimedia approach would encourage whatever pollution prevention and control measures led to the greatest byproduct reductions considering costs. For example, performance-based standards applied site-wide would facilitate diffusion of effective technology by allowing more flexibility to reduce pollution.[191]

The incentive extends beyond diffusion, to innovation as well. Multimedia standards both encourage the prevention of pollution and direct business' attention to the place where it can be done most effectively. Despite its great advantages, multimedia standards face substantial policy, statutory and practical administrative obstacles.

At the policy level, multimedia standards require difficult trade-off decisions to assure that particular standards actually lead to improved environmental protection. As long as total discharges fall, a pure multimedia standard is indifferent to the medium into which the remaining pollutants are discharged. However, different media may vary widely in their sensitivities to specific pollutants. There is nothing to prevent a discharge into one highly sensitive medium in order to obtain the necessary decrease in the discharge into another, less sensitive, medium. To assure net environmental improvement, there must be a careful analysis of the trade-offs in environmental impacts of cross-media impact shifts.

This is a complex analysis, and one to be avoided if possible. However, the possibility that it may be required should not be fatal to a multimedia approach. Such trade-offs are implicit in con-

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190. *See, e.g.*, sources cited *supra* note 187.

191. *See* EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93, at 21.

ventional medium-specific standards, although they are now ignored for the most part. Present medium-specific standards often result in changing the amount of discharge into different waste streams, with typically little or no analysis of the environmental effects of this change. In this respect, the added complexity of writing multimedia standards is a blessing. It results from addressing issues that should be considered, but are often ignored, in our present single medium standards. While our current answers are incomplete, the question is presented regardless, and clearly posing it may help us develop better answers.

The existing framework of environmental statutes presents tremendous obstacles to multimedia standard setting.[192] Incremental revisions would emphasize agency discretion and multimedia coordination in current single medium standards, which then could be incorporated into reauthorization of single-medium statutes. This approach offers marginal incorporation of multimedia thinking, albeit without meaningful reduction of the complexity of satisfying the current single-medium requirements. A bolder approach would entail replacing the single-medium statutes with one integrated multimedia standard. This kind of radical change appears unlikely in the foreseeable future. Without bold, fundamental revision of the statutes, EPA faces formidable challenges in writing multimedia standards, because these must also satisfy the single-medium criteria of each statute. For example, the multimedia rule would have to adopt the appropriate technology-based standard for water discharges and satisfy the largely health-based Clean Air Act at the same time.[193] This is not impossible; indeed, a good multimedia rule should also provide appropriate protection within each medium. However, ensuring that a multimedia rule meets each specific criterion of every single medium statute — and can be shown to do so adequately in the inevitable court challenge to it — does make the process much more complex.

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192. As discussed *infra* Part V.A., such standards must satisfy the requirements of each single-medium statute simultaneously.

193. *See* 33 U.S.C. § 304 (1994) (defining CWA's technology based standards for existing sources. CAA's health and welfare based standards for existing sources are at 42 U.S.C. § 7409 (b) (1994). Each media-specific statute includes several different regulatory programs and statutory standards, such as more restrictive requirements for new sources, and these would each have to be satisfied to sustain the rule.

EPA is now organized predominantly along media lines, and this presents a second limitation. Reorganizing EPA along industry sector based lines would greatly facilitate multimedia standard-setting, as well as permitting and compliance. This idea has been discussed since EPA's very beginnings.[194] The cost in disruption and delay of operations would be quite high. Additionally, the agency would have to develop more industry-specific expertise, which would also be disruptive and expensive. Finally, operating a multimedia agency under single media-specific statutes would present ongoing problems of coordinating agency authority and providing appropriate information to Congress.

Given the complexity of the task, is multimedia standard setting possible without boldly revising the statutory framework and reorganizing the agency? The Source Reduction Review Project (SRRP), begun in 1992, attempted the more modest task of coordinating single-media rulemaking to maximize cross-media outcomes, without reorganizing the agency.[195] Work groups were drawn from the individual single medium offices and other EPA offices, with the coordinating efforts of the Office of Pollution Prevention and Toxics, to introduce source reduction and multimedia thinking into targeted rulemaking efforts.[196] According to the 1993 status report, the program emphasized eight specific industrial categories and ten specific rulemaking efforts within them. EPA's air, water, and solid waste offices collected more multimedia data and engaged in more cross-media analysis.[197] The project proposed coordinated air and water rules in the pulp and paper industry.[198] Six other rulemaking efforts did

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194. *See, e.g.*, MARC K. LANDY ET AL., THE ENVIRONMENTAL PROTECTION AGENCY: ASKING THE WRONG QUESTIONS (1990).

195. An excellent, comprehensive evaluation of the program and the lessons to be learned can be found in EPA, PREVENTING POLLUTION THROUGH REGULATIONS: THE SOURCE REDUCTION REVIEW PROJECT -AN ASSESSMENT (EPA-742-R-96-001 1996).

An earlier EPA effort was concerned with 13 separate regulatory "clusters". Some clusters were based on industry sectors and some on significant environmental problem areas. Clusters were made up of teams of EPA staff from relevant program offices. Teams met to try to integrate formally separate activities. *See* Fontaine, *supra* note 6, at 80-81.

196. *See* EPA, PREVENTING POLLUTION, *supra* note 195, at n.1.

197. *See id.* app. B.

198. *See id.* at B1-B2. The proposed air and water rules are Effluent

eventually incorporate some source reduction efforts.[199]

The key structural characteristic of the SRRP was its overlay on top of existing agency structure and ongoing rulemakings and priorities. Thus, the commands of existing statutes and the existing single-medium structure of the agency were all fixed points of departure for the project.[200] However, the project has clearly indicated that these fixed reference points impose quite dramatic constraints on multimedia regulation.[201]

First, the agency's flexibility is greatly limited by the commands of existing single-medium statutes, and court orders enforcing them, which set medium-specific criteria to guide agency standard setting, such as technology-based standards for water and health-based standards for air and waste disposal.[202] Coordinating priorities, timetables, and resource allocations among different program offices creates a second problem.[203] Different program offices are often on different schedules for gathering data and issuing rules. The agency has little flexibility to change these deadlines without specific legislative authorization.[204] As a result, it is difficult for EPA to address all media aspects of an industry at the same time.[205] Resolving cross-media issues within a single-media rulemaking context simply expands the workload.

However, in some cases the agency sets these schedules and thus theoretically could alter them to coordinate deadlines. This is not a simple matter, because the rulemaking schedule also reflects the relative priorities of the underlying program offices, such as air or water, so these would have to be changed, as

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Limitations Guidelines, Pretreatment Standards and New Source Performance Standards: Pulp, Paper and Paperboard Category; National Emissions Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production; Availability, 61 Fed. Reg. 36,835 (July 15, 1996). The proposal has been criticized for insufficiently coordinating standards across media, and for failing to require installation of chlorine-free processes that are available. For a summary of this and the other six rulemaking efforts on which the project was active, see *id.*

199. *See id.* at B2-B9.

200. *See id.* at 9.

201. *See id.* at 7-11.

202. *See id.* at 9.

203. *See id.* at 8-11.

204. *See id.* at 8-10.

205. *See id.* at 7-8.

well.[206] The program offices' different priorities would also be reflected in other relative allocations such that the rulemaking would progress at different rates in the various program offices.

While the SRRP achieved some coordination on its targeted rulemakings, its source reduction and multimedia goals have not been deeply institutionalized into the regular daily workings of the program offices. A principal recommendation emerging from the SRRP is that agency planning and budgeting must be reconfigured to support multimedia regulation and, hence, pollution prevention.[207] SRRP showed that source reduction and multimedia thinking can be incorporated into the existing regulatory framework to a degree. However, it also demonstrated that a robust multimedia approach to regulation will require much more fundamental change both in the environmental statutes and in the agency structure and operations.

SRRP was a policy favorite of William Reilly, the last administrator of EPA. Subsequent initiatives under Carol Browner, the present administrator, have eclipsed it. In the summer of 1994, Browner announced a partially overlapping new program, the Common Sense Initiative (CSI).[208] The CSI aims to make environmental regulation more cooperative by convening six industry-specific teams of representatives from regulatory agencies, industry, environmental groups, and other stakeholders.[209] The teams were then to evaluate how regulation can be made more effective and efficient through cooperative efforts and projects.[210] The initiative deals with permitting, enforcement and crafting better regulations.[211] No specific regulatory changes have yet

206. *See id.*

207. *See id.* at 18-23.

208. *See* EPA, THE COMMON SENSE INITIATIVE: A NEW GENERATION OF ENVIRONMENTAL PROTECTION, EPA INSIGHT POLICY PAPER (EPA 175-N-94-003, Aug. 1994).

209. *See id.*

210. *See* EPA, COMMON SENSE INITIATIVE UPDATE 12 (July 1994).

211. *See id.*; EPA, THE COMMON SENSE INITIATIVE, *supra* note 208. The 1995 progress report notes that alternative regulatory approaches are proposed as pilot projects for four of the six industry focus groups — auto manufacturing, computers and electronics, metal finishing, and petroleum refining. *See* EPA, COMMON SENSE INITIATIVE UPDATE (Aug. 1995); *see also* EPA, PREVENTING POLLUTION THROUGH REGULATIONS, *supra* note 196, app. A (discussing ways in which the lessons of the Source Reduction Review Project can be used to advantage in the Common

been proposed by the industry teams.

In April, 1995, the White House and EPA announced a series of "reinventing government" initiatives, followed by a new Environmental Technology Policy.[212] Some of the reinventing government initiatives, particularly Project XL, have the potential to replace SRRP and overlap with CSI, as does part of the new technology policy.[213] However, the programs make little reference to the earlier initiatives, CSI and SRRP, and the publicly available information does not reflect any serious attempt to coordinate the projects.

With this blizzard of overlapping programs, it is difficult to determine the relative policy priority of multimedia standard setting. The newer initiatives have broad goals and can be read to embrace multimedia rulemaking,[214] but the latter is not practical without clearer and firmer policy leadership and support. The idea of setting multimedia standards has not progressed beyond the one-shot, pilot project exploration of interesting possibilities; it shows little sign of a broad and sustained integration into core regulatory activities. For now, single-medium standard-setting continues to be business as usual within EPA and major efforts will be required to change this.

2. Targeting Standards for a Likely Business Reaction

While pollution prevention and the requisite technological change require action by business, specially crafted environmen-

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Sense Initiative). The June 1997 progress report notes 40 ongoing projects and 150 stakeholder participants. *See* EPA, COMMON SENSE INITIATIVE UPDATE (June 1997).

212. *See* BRIDGE TO A SUSTAINABLE FUTURE, *supra* note 1; President Bill Clinton & Vice President Al Gore, Reinventing Environmental Regulations (Mar. 16, 1995). EPA's internal policy was proposed in EPA, TECHNOLOGY INNOVATION STRATEGY, EPA-543-K-93-002 (Jan. 1994).

213. *See* EPA, TECHNOLOGY INNOVATION STRATEGY, supra note 212. Project XL envisions alternative environmental standards, permitting, and enforcement for selected volunteer companies. EPA guidelines for the program are in 60 Fed. Reg. 27,282-91 (May 23, 1995), and in Guidelines for Development of XL Projects, 62 Fed. Reg. 19,871-82 (Apr. 23, 1997). For a review of the program, see NAPA, RESOLVING THE PARADOX OF ENVIRONMENTAL PROTECTION 11-17.

214. *See* EPA, TECHNOLOGY INNOVATION STRATEGY, supra note 212.

tal regulatory standards can be prime motivators.[215] Traditional single-medium standards are intended to motivate a straightforward business response: control emissions.[216] However, standards could be written to support a more sophisticated business response: prevent pollution rather than control it. This is a much more complicated undertaking because pollution prevention requires innovative thinking, as well as organizational support — ultimately a whole change in the corporate culture.[217] The subtlety and complexity of this activity means that it will be difficult to command directly, and a sophisticated strategy will be needed to motivate it indirectly.

Technology-friendly regulation must begin with a broad assessment of the technological options in a particular industry setting.

> TOA's [Technology Options Assessments] can identify technologies used in a majority of firms that might be *diffused* into greater use, or technologies that might be *transferred* from one industrial sector to another. In addition, opportunities for technology development (that is, innovation) can be identified . . . . Only by requiring or undertaking TOA's itself is government likely to facilitate major technological change. Both industry and government have to be sufficiently technologically literate to ensure that the TOA's are sophisticated and comprehensive.[218]

For example, a TOA might indicate that many firms have not adopted available technology, so a regulatory strategy aimed at achieving diffusion would be the preferred priority.[219] On the other hand, the assessment might indicate that fundamental in-

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215. *See* Strasser, *supra* note 2, at 11-15 (for a discussion of what pollution prevention requires of business).

216. *See* Ashford, *Innovation Based Strategy*, *supra* note 1, at 275-77; NACEPT, EPA, TRANSFORMING ENVIRONMENTAL PERMITTING AND COMPLIANCE POLICIES TO PROMOTE POLLUTION PREVENTION: REMOVING BARRIERS AND PROVIDING INCENTIVES TO FOSTER TECHNOLOGY INNOVATION, ECONOMIC PRODUCTIVITY, AND ENVIRONMENTAL PROTECTION 22 (EPA-100-R-93-004, Apr. 1993) [hereinafter EPA, TRANSFORMING ENVIRONMENTAL PERMITTING].

217. *See* Strasser, *supra* note 2, at 11-12.

218. Ashford, *Innovation Based Strategy*, *supra* note 1, at 302.

219. *See id.* at 303-04 (different regulatory tools will then be emphasized).

novation is needed in a technologically mature industry. In this situation, stringent regulation is probably necessary, either to induce a crisis that might motivate a resistant established business with a mature technology, or to offer a more attractive entry opportunity to suppliers or other potential entrants.[220]

In addition to evaluating what technological change is needed and possible, the TOA must consider all the firm and industry specific factors that are likely to be important in predicting who might make the change, and when. As discussed above, the fluidity or maturity of the underlying firm and industry technology is a most important factor.[221] Beyond this, do the candidate firms show the flexible organizations and management styles that are more likely to embrace technological change? Does the market offer entry opportunities that make upstream suppliers or downstream customers viable candidates to implement technological change as part of an entry strategy?[222] If radical innovation is needed, three factors are especially important in evaluating whether it is likely to come from within the industry or from outsiders. First, radical innovation is most likely to come from insiders if the products are non-assembled ones; from outsiders if products are assembled. Second, radical innovations that create substitute products tend to come from insiders; those that create new or expanding markets from outsiders. Third, insiders are associated with innovations that enhance existing technical and business competencies within the industry, while competency-destroying innovations more often come from outside firms. In addition, firm size and the dynamic efficiency of the markets in

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220. *See* Ashford et al., *Using Regulation*, *supra* note 3, at 433.

> There were two types of technological responses to PCB regulation: (1) continued use of PCBs with reduction of associated hazards and (2) development of substitutes. The first response, ultimately abandoned, included Monsanto's introduction of a new, more biodegradable PCB mixture for use in capacitors and a new Westinghouse capacitor design, reducing PCB use by sixty-six percent. The second response was the development of five PCB substitutes . . . . Overall, PCB regulation caused modest process innovation and radical and comprehensive product innovation.

Id.

221. *See supra* notes 26-32 and accompanying text.

222. *See supra* notes 33-37 and accompanying text.

question will also be important.[223]

However, caution is necessary when making and using technology assessment options. Regulators must avoid making de facto governmental determinations of what technology should be developed, how it should be pursued, and by whom. Rigid or precise technology specification by regulatory agencies is certain to discourage the creativity and effort necessary for fundamental technological change.[224]

The next step, after assessing technological possibilities, is to consider the regulatory tools available to encourage the preferred technological development. Product and process standards often spark very different business reactions.[225] Standards that specify levels of performance, rather than technology, have often been advocated to encourage creative business responses but the practical difficulties are considerable.[226] The Clean Water Act, for example, authorizes EPA to set performance standards based on available technology, but risk-averse firms have tended to expedite compliance by limiting their responses to the specific technologies underlying those standards.[227]

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223. *See supra* notes 55-59 and accompanying text.

224. *See* F. Anderson, *From Voluntary Regulation to Pollution Prevention, in* ENVIRONMENTAL STRATEGIES FOR INDUSTRY, *supra* note 17 (discussing this concern and expressing pessimism that regulators will be so restrained).

225. *See supra* Parts III.C, D.

226. *See, e.g.*, Stewart, *Regulation*, *supra* note 76, at 1317-19 (advocating greater flexibility and longer lead times to encourage innovation).

227. *See id.* at 1268-69.

> Engineering standards are a hybrid of performance standards and specifications. In form, they are expressed as pure performance standards. In practice, they are based upon the level of performance that can be achieved by a specific input or technology. . . .
>
> While regulated firms are in theory free to meet the required level of performance any way they choose, they have strong incentives to adopt the particular technology underlying the standard because its use will readily persuade regulators of compliance.

Id.

See also Stewart, *Economics*, *supra* note 76, at 4-5. "In practice . . . effluent limitations strategy of the Clean Water Act have been implemented through regulations requiring sources to use available and affordable technology." *Id.*

After determining the technology options and the regulatory tools best calculated to achieve them, the standards writer must consider whether the statutes authorize use of these tools. Most environmental statutes authorize broad discretion, although regulators have not often employed it.[228] The Clean Water Act authorizes product bans for discharge of toxics[229] and appears to countenance setting effluent standards for conventional pollutants with reference to prevention technologies.[230] New source performance standards can be set with reference to "processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutant."[231] Further, EPA has substantial discretion in issuing permits and supervising state permitting, and this can be used to support or require pollution prevention.[232]

The Clean Air Act also offers some opportunity for targeting standards toward pollution prevention. The nationwide ambient standards at the core of the regulatory system are set at a level

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228. This discussion draws heavily on the excellent study, ELI, THE TOOLS OF PREVENTION: OPPORTUNITIES FOR PROMOTING POLLUTION PREVENTION UNDER FEDERAL LEGISLATION 2-22 (1993).

229. *See* 33 U.S.C. § 1317(a)(2) (1994) (authorizing effluent standards for toxics, based on best available technology, "which may include a prohibition"); ELI, TOOLS OF PREVENTION, *supra* note 228, at 3-4.

230. The Act authorizes regulators to consider a broad array of factors in setting standards. *See* ELI, TOOLS OF PREVENTION, *supra* note 228, at 15-16 (citing H.R. REP. NO. 92-911, at 102 (1972))

> The statutory factors that must be considered in developing guidelines are quite flexible. The BAT [best available technology] factors, for example, include "process changes" and "such other factors as the Administrator deems appropriate" (citing CWA § 304(b)(2)(B)). The fact that BAT can include source reduction measures is supported by the zero-discharge goal of the act. Indeed the legislative history of the act makes it clear that, in setting BAT, the agency should consider "the total plant" and not just "the control techniques used at the actual discharge of the point source."

Id.

231. *See* 33 U.S.C. § 1316(a)(1) (1994).

232. *See* ELI, TOOLS OF PREVENTION, *supra* note 228, at 5-8. States could also require prevention under their implementation of the water quality standards program, although the water quality standards have not, in practice, proven to be a very effective way of accomplishing environmental protection. *See id.* at 16-18.

necessary to protect the public health.[233] These ambient standards do not directly create emissions limits for individual sources. Limits come from state implementations plans ("SIPs") that set emissions limits for individual sources.[234] While the SIP must meet a number of federal requirements, these neither mandate nor forbid targeting standards to promote technological change.[235] That issue will be one for state administrative discretion, controlled by state law and state courts.

However, the Clean Air Act also supplements these ambient standards with technology-based standards for stationary sources,[236] and these could be used to support and encourage technological change. When a new source starts operating in a dirty air area, that source must meet the lowest achievable emission rate — that is the lesser of the lowest required in any state's SIP or the lowest actually achieved in practice.[237] In addition, all new sources must meet standards that reflect the "best system . . . adequately demonstrated".[238] Air toxic levels must now be brought to the "maximum degree of reduction . . . achievable . . . (including a prohibition on such emissions, where achievable)".[239] In determining what is technologically possible under this provision, EPA can consider process changes, materials substitution, as well as "design, equipment, work practice, or operational standards . . . ."[240] These regulations may provide the basis

233. *See* 42 U.S.C. § 7409(b)(1) (1995). Secondary standards are to protect the public welfare. *See id.* § 7409(b)(2).

234. *See id.* § 7410(a)(2)(A).

235. *See id.*

236. *See id.* § 7410 (a)(2)(A)-(E).

237. *See id.* §§ 7503(a)(2), 7501(3).

238. The full definition is "the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any non-air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated." *Id.* § 7411(a)(1).

239. The standards are to require "the maximum degree of reduction in emissions . . . (including a prohibition on such emissions where achievable) that the Administrator, taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements, determines is achievable for new or existing sources . . . ." *Id.* § 7412(d)(2).

240. *See id.* § 7412(d)(2)(A), (D).

for an expansive determination of what controls are "achievable" and where such standards would be useful in targeting regulations toward technological change. However, they are the most restrictive versions of a technology-based standard. They can certainly be used to require technology diffusion, although how much innovation beyond existing technology is problematic.

Other parts of the Clean Air Act authorize regulatory standards that force technology development. CAA authorizes EPA to use the technological possibilities "which the administrator determines will be available for the model year" in question when setting emission limits for heavy duty vehicles and engines.[241] When the agency set standards for diesel engines, it looked to a technology that was under development but not then proven. In upholding the agency's standards, the Court of Appeals for the District of Columbia Circuit held that such technology forcing was authorized if it met three tests:[242]

> We think the EPA will have demonstrated the reasonableness of its basis for prediction [that the new technology will be available] if it [1] answers any theoretical objections to the trap-oxidizer method [the technology in issue], [2] identifies the major steps necessary in refinement of the device, and [3] offers plausible reasons for believing that each of those steps can be completed in the time available.[243]

These criteria offer some guidance as to what would be required of a regulatory standard that consciously seeks to force technology. It is limited guidance, primarily because the particular statutory standard is atypical in authorizing the agency to anticipate future technology and require it. Beyond this, technology forcing — rather than technology promotion — is likely to be a limited strategy. While forcing may lead to diffusion, more fundamental innovation requires a level of business creativity and initiative that will be hard to force.

RCRA also provides some agency discretion to target standards. Waste generators[244] who ship wastes off site must certify

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241. *Id.* § 7521(a)(3)(A) (emissions limits for automobiles are often cited as an example for technology forcing by Congress).

242. *See* National Resources Defense Council, Inc. v. EPA, 655 F.2d 318, 331-32 (D.C. Cir. 1981).

243. *Id.*

244. *See* 40 C.F.R. § 260.10 (1997) (defining "generator" as "any person, by site, whose act or process produces hazardous waste identified or listed in part 261 of this chapter or whose act first causes a haz-

that they have "a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable."[245] Although this has proven to be a toothless program in practice,[246] the statute's language indicates that the agency could require more under this provision than it currently does.[247]

RCRA's so called "land-ban" could also support prevention-oriented standards.[248] That provision bans land disposal of hazardous wastes unless they have been treated in compliance with technology-based treatment standards, or their containment is shown.[249] Treatment is broadly defined to include "any method, technique, or process, including neutralization . . . [designed] to neutralize such waste or so as to render such waste nonhazardous, safer for transport, amenable for recovery, or reduced in volume."[250] This breadth, combined with the waste minimization purposes embraced in the act's policy sections, makes prevention standards practically available, within the agency's discretion.[251]

While the existing environmental statutes generally require media-specific pollution control standards, their breadth authorizes substantial discretion to pursue pollution prevention and technological change. As this discretion has rarely been used, neither EPA nor the courts have had occasion to define its limits. Technology-based standards usually focus on some version of available technology, and the key inquiry here is whether the standards can be used to encourage or force the innovation needed to develop new technology. There should be no serious question that they can be used to require diffusion of existing technology. Health-based standards appear to authorize whatever level of restriction protection of health requires, including adoption or innovation of technology.

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ardous waste to become subject to regulation.").

245. 42 U.S.C. § 6922(b)(1) (1994). They must also describe the waste reduction efforts in biennial reports. *See id.* § 6922(a)(6)(C)-(D).

246. *See* ELI, TOOLS OF PREVENTION, *supra* note 228, at 9-12.

247. *See id.* at 11.

248. *See id.*

249. *See* 42 U.S.C. §§ 6924(m)(1) (specifying treatment technology requirements), 6924(d)(1) (specifying the containment requirements) (1994).

250. *Id.* § 6903(34).

251. *See* ELI, TOOLS OF PREVENTION, *supra* note 228, at 20-21.

The statutes regulating toxic substances and pesticides also allow discretion to promote environmental technology. These regulatory regimes authorize a broad array of possible regulatory controls, extending to product bans, any of which could presumably be tailored to promote environmental technology.[252] FIFRA specifically authorizes special permits for experimental use to assist applicants in accumulating information needed to apply for permanent registration.[253] TOSCA policy states that regulatory authority shall not be used "to impede unduly or create unnecessary economic barriers to technological innovation . . . ."[254]

Bans on existing products, when used, have proven to be an effective way to encourage technological innovation by creating a market for new ones that are presumably cleaner.[255] Such a policy requires that the agency be able to make sophisticated evaluations of the possibilities for technological change.

Product bans have been used only in response to absolute environmental risk presented by the substance or product, and then only infrequently. The question is whether they could be used in response to relative risk: whether the existing product can be banned because a less risky product is or will then become available. Where an existing product poses more risk than a new substitute would, this increased risk is unreasonable under the statutory standard. Determining the relative degrees of risk posed is not an exact science, however. Moreover, the range of discretion courts are — or would be — willing to grant administrators in making this determination is not clearly indicated in the limited case law on product bans.[256]

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252. FIFRA authorizes denial of registration, or a broad array of use and sale restrictions on specific pesticides, as well as a total refusal to register them for sale at all. *See* 7 U.S.C. § 136a(c)-(d) (1994). TOSCA similarly authorizes product limitations and a complete ban if this is justified. *See* 15 U.S.C. § 2605(a). For a further discussion of the impact of these statutory schemes on technology development, see *supra* Part III.D.

253. *See* 7 U.S.C. § 136c(a) (1994).

254. 15 U.S.C. § 2601(b)(3) (1994).

255. *See* Rest & Ashford, *Formaldehyde, supra* note 33; *see also supra* text accompanying note 33.

256. *See* Corrosion Proof Fittings v. EPA, 947 F.2d 1201 (5th Cir. 1991) (reversing most of the agency's ban of asbestos use under TOSCA, finding that the agency had not given sufficient consideration to less burdensome regulatory options as required by the statute, al-

In successfully targeting regulatory standards to promote environmental technology, regulators face sophisticated demands. Regulators must first understand how, when and why business develops and deploys new technology. Second, they must understand more clearly what impacts different regulatory tools will have on this process. Third, regulators must exploit and develop the available discretion offered in the existing environmental statutes to use the proper regulatory tools effectively. This is not an impossible job, but it is a demanding one that calls for new learning and skills on the part of sophisticated regulators.

3. Setting Standards to Allow for Uncertainty and Delay

Pollution prevention depends on technological change: an often irregular and uncertain process. Where the change involves diffusion of known technology, some adaptation is almost always necessary. Where more fundamental innovation is involved, the process is even less determinate. With both diffusion and innovation, further incremental development and fine tuning are often quite likely to be required. Environmental policy must allow for these delays and uncertainties if it is to foster technological change.

This subsection will discuss three ways that environmental standards should allow for uncertainty and delay. The use of innovation waivers to delay regulatory deadlines, where innovative compliance efforts are made, will be discussed first. Second will be the use of special permits for testing and evaluation of innovations. Third is the need for so-called "fail soft" strategies, making special allowance for violations that result from innovative efforts that do not perform as well as planned.

Innovation waivers typically provide for delay in compliance deadlines when a new technology is used to achieve compli-

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though the court did emphasize the importance of consideration of the availability and risks presented by likely substitute products, and this provides some indirect support for the approach proposed in the text above); CIBA-Geigy Corp. v. EPA, 874 F.2d 277 (5th Cir. 1989) (reversing EPA's decision to cancel the registration of the pesticide diazinon under FIFRA, while reaffirming the administrator's authority to cancel for unreasonable risks without requiring a finding of actual adverse effects of use).

ance.[257] While waivers need not be restricted to pollution prevention technology, they would typically apply to it as well as to new pollution control or cleanup technology.[258] Innovation waivers support incremental process changes. Because radical innovation usually requires long time periods, innovation waivers will probably have little influence on it.[259] In theory they should not apply to diffusion of known technology, because it should not qualify as sufficiently innovative. However, where substantial adaptation is required, particularly where the diffusion is of technology used only in another industry, it could qualify for a waiver.

Innovation waivers are authorized under both the Clean Water Act and the Clean Air Act.[260] The history of their use, however, is not encouraging. As of 1994, only ten waivers had been issued over the life of the Clean Water Act program.[261] There seems to be little interest in these programs today.[262] An EPA study of the Clean Water Act program found several reasons for this infrequent use.[263] Firms surveyed felt that the innovation waivers were simply too risky a prospect.[264] The innovative technology might

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257. *See* EPA, PROVIDING WAIVERS FROM NPDES PERMIT COMPLIANCE SCHEDULES FOR INDUSTRIAL POLLUTION PREVENTION TECHNOLOGY 1 (EPA-820-R-003, May, 1994) [hereinafter EPA, PROVIDING WAIVERS].

258. *See id.*; *see also* Ashford et al., *Using Regulation, supra* note 3, at 443-62.

259. *See* Ashford et al., *Using Regulation, supra* note 3, at 463.

260. *See id.*

261. *See* EPA, PROVIDING WAIVERS, *supra* note 257, at 37-38; Stewart, *Regulation, supra* note 76, at 1307-08.

262. However, HR 961, the House passed reauthorization of the Clean Water Act, contains a major revision of the Clean Water Act innovation waiver provision, *Id.* § 321.

263. *See* EPA, PROVIDING WAIVERS, *supra* note 257, at 47-48.

264. *See id.* at 49-51.

> The fundamental difficulty of the 301(k) [the Clean Water Act] innovation waiver is that it provides for an exceptions process under which all parties are subject to intense scrutiny. . . . Because the innovation waiver is an exceptions process, it generates focused attention on all the parties involved. Each is likely to feel increased vulnerability in the decision process. The result has been clearly apparent in the fourteen year history of the 301(k) provision. Public Interest groups and agency personnel have generally been opposed

fail, and applicants were offered little assurance of "fail-soft" enforcement if good faith efforts didn't succeed, completely, and on time.[265] Even if the technology succeeded, firms were discouraged by the special investments of financial, managerial and worker training resources that were required.[266] In addition, the details of the program were unclear and uncertain.[267] Implementing regulations were delayed, depriving potential applicants and agency personnel of guidance on the program.[268] Further, agency officials feared being too lenient, thereby allowing abuse of the program simply to delay compliance, and this led to restrictive application of the provision.[269] Agency personnel felt that deciding each waiver application required resources that could more profitably have been spent dealing with broader issues.[270]

The Clean Air Act provisions did have some limited use, although generally they have had a similar history.[271] Ambiguous legislation created confusion about what technological change qualified for a waiver, as well as how well demonstrated a technology had to be.[272] Qualifying technology had to be sufficiently innovative that it had not yet been "adequately demonstrated," but the applicant still had to show that the technology would operate effectively in order to get a waiver to try it.[273] While not theoretically impossible to use, this was simply too fine a distinction to be applied at the early stages of the uncertain process of developing new technology. In addition, the Agency did not provide timely guidance. All of these factors led to extended and disruptive delays in approving applications. Strict statutory time

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> to the process, agency personnel have been unwilling to encourage applications for the waiver, and companies have either preferred to look for other mechanisms under which to promote innovations, or to avoid the risks altogether.

Id.

265. *See id.*
266. *See id.* at 29-34.
267. *See id.* at 34-35.
268. *See id.*
269. *See id.*
270. *See id.* at 34-36.
271. *See* Ashford et al., *Using Regulation, supra* note 3, at 448-52.
272. *See id.* at 448-52.
273. *See id.* at 449.

limits on the duration of the waiver further discouraged use of the provision.[274]

Some of the problems — clearer program delineation, a "soft landings" compliance policy, and deadline flexibility — can be fixed with improved program administration. However, the underlying need for more responsive and supportive program policy will be difficult to meet within an agency that sees enforcement of pollution control restrictions as its primary mission. One alternative policy is to authorize special permitting for testing and demonstration projects, lowering the stakes for both parties.

The question was carefully considered in a 1991 report to EPA from the Technology Innovation and Economics Committee of the National Advisory Council for Environmental Policy and Technology,[275] which concluded that present permitting systems are a major impediment to testing and demonstrating innovative technology.[276] Specialized permitting offers an opportunity to develop new technology and demonstrate its performance without risking the whole facility's compliance. Emissions control standards that authorize specialized permitting will encourage technological change.

Under present law, there is only limited authorization for such specialized permitting.[277] RCRA authorizes a permit process for "research, development and demonstration" but this authority has been narrowly construed and, from 1985 to 1991, only fifteen such permits were issued.[278] Neither the Clean Air Act nor the

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274. *See id.*

275. EPA, PERMITTING AND COMPLIANCE POLICY: BARRIERS TO U.S. ENVIRONMENTAL TECHNOLOGY INNOVATION (EPA-101/N-91/001, Jan. 1991).

276.

> *Finding 5.* The cost, risk, and complexity of permitting systems associated with testing and demonstrating innovative technology for environmental purposes is excessive. There are few locations in the United States where tests and demonstrations of innovative technologies can be performed. No viable permitting process exists for those few that do.

Id. at 29.

277. *See* 42 U.S.C. § 6925(g) (1994).

278. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 56. Only 10 states are authorized to issue such permits. For a summary of proposed detailed program modifications needed to improve

Clean Water Act specifically authorizes testing permits, although ad hoc administrative actions have been used to allow them in specific cases.[279] Being ad hoc, these provide little assurance of future regulatory action that technology developers require. EPA's 1994 technology policy proposed specialized permits for technology development and testing although there has not yet been much implementation.[280]

New legislation will likely be required before widespread use of testing permits is possible. The 1991 study proposed specific guidelines for such a permitting program, emphasizing controls to insure environmental safety, ten year multimedia permits, and public review as part of the process.[281] From a policy perspective, the key first step is to clearly articulate a policy of support for testing and demonstration. However, simply announcing a new policy will not be enough; both the existing statutes and regulations must change. Beyond this, agency program offices must be created or restructured to create specific institutional support for such permitting. The law and the mindset of the existing agencies is focused on pollution control in the permitting process. Those statutes and that mindset must change if specialized permitting, and the resulting support of technological change, are to become reality.[282]

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the workability of this program, see *id.* at 54-56.

279. *See id.* at 57.

280. *See* EPA, TECHNOLOGY INNOVATION STRATEGY, *supra* note 213, at 14.

281. *See id.* at 54-58.

282. Although not a specialized permitting program, EPA has had the Superfund Innovative Technology Evaluation program (SITES) since 1986. This is a demonstration program for testing and evaluating new technology at superfund cleanup sites; it offers limited financial support for testing and evaluation, as well as certification and publication of the results. The program has a limited scope; in fiscal 1995 it spent about $12 million to demonstrate 11 technologies. *See* GAO, Superfund: Use of Innovative Technologies for Site Cleanups, Testimony of Lawrence J. Dyckman, Assoc. Director for Environmental Protection Issues, before the Subcommittee on Energy and the Environment, Committee on Science, House of Representatives (Dec. 6, 1995). No special permitting relief is offered, although the program offers its participants the same limited protection from further liability based on the cleanup efforts that it offers all its contractors at cleanup sites. *See*

In addition to authorizing innovation waivers and specialized permitting, technology-friendly pollution standards must allow for the almost certain failures and incomplete successes entailed in any widespread program to support technological change. This so-called "fail soft" strategy is a key part of encouraging environmental technological change.[283] Provision can be made for reduced penalties where there is a good faith belief that compliance will be achieved, and no serious risk to health or the environment results.[284]

When innovative efforts simply fail and the company must back up and start over with another technological approach, compliance will be delayed substantially, with likely poor environmental performance during the delay. Should any allowance be made for failed efforts, either in penalty policy or in delaying deadlines? Given that there is always some real risk of failure with any technological change, and a greater risk where the change is a more radical innovation, the prospects for innovation will likely be reduced substantially if no allowance is made. Individual innovators will be less likely to conceive the projects, and company decision makers will be less likely to fund and support them.

Failed efforts present the greatest risks of environmental harm, however. Failed efforts mean poor environmental performance during the time it takes to install other technology. Furthermore, any policy that offers regulatory relief for failed efforts may be abused. The policy could attract requests and proposals that are not sincerely motivated, but are rather aimed at exploiting the relief with only a pretense of actually developing new technology.

EPA, Superfund Response Action Contractor Indemnification, 58 Fed. Reg. 5972 (Jan. 25, 1993). No comprehensive evaluation of the program's impact on development and implementation of new technology has been found.

283. This term is first used, and the policy is advocated in, Ashford et al., *Using Regulation, supra* note 3, at 455-56. *See also* EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93, at 93; EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 68, 78.

284. Ashford et al., *Using Regulation, supra* note 3, at 455-56 (discussing one such provision in enforcing such a waiver).

However, making provision to waive penalties and extend compliance deadlines is still necessary to encourage innovations.

While primarily a matter of enforcement policy, by specifying in advance the requirements of its "fail soft" policy, EPA and state regulators can reassure technology developers, providing a useful incentive. Such a policy must ensure that no substantial increased risk to health or the environment has resulted from the technology's failure to meet the standards. It must also evaluate the company's good faith, as well as the time and resources needed to achieve compliance. Finally, the extent of real innovation and potential environmental benefit that was offered by a specific project should also be considered.

In summary, this section shows that much can be done to encourage technological change in setting particular environmental standards. Considering the firm and industry characteristics discussed in Part II, the type of regulation used — emissions limits or product limits — will determine the strength of the motivation of pollution prevention technological change. Enforcement stringency and flexibility are both important. Sophisticated standards that encourage technological change should be multimedia ones. Standards should target industries and preferred technological responses, and there should be some toleration of uncertainty and delay.

There is a substantial, mixed history of the use of most of these tools. However, their use has been in the course of ad hoc policy efforts, often isolated activities, pilot programs, or other efforts outside the regulatory mainstream. This doubtless results from the fact that the mainstream has historically been concerned with pollution control, while pollution prevention has been confined to the regulation's isolated backwaters and remote tributaries. The first step is a clearer policy focus on prevention and technological change, moving these to the regulatory mainstream. Such an effort can institutionalize this new direction within regulatory agencies. With this new direction established, a more effective use of these policy tools will become possible.

IV. Permitting and Technological Change

A. *The Bias Against Technological Change in Environmental Permitting*

Permitting is the second stage of the traditional environmental regulatory system. Regulatory officials write permits that authorize a particular amount of discharge from a particular pollution source. Most federal environmental laws authorize delegation of permitting and enforcement to states, under federal supervision,[285] and most states have sought and received authority to operate these programs for air, water, and waste disposal. As a result, most permit writing is done by state officials, even under the federal regulatory standards. Where general standards have been written, permits create specific discharge rules for individual facilities and plants. If no general standards have yet been written for this type of source, permit writers must make individual, case-by-case determinations of the applicable requirements.

A permit written for an individual business or facility is the most precise statement of what environmental regulation requires of the business at that time. The permit sends a clear message of what must be done to satisfy environmental law. Further, the message does not arrive unanticipated, for getting a permit usually involves the company in an information exchange and negotiation process leading up to it. If this opportunity were properly managed, it could be used to encourage and support technological change and pollution prevention. Sadly, this is not usually the case.

The process of writing environmental permits is biased toward safe, technologically conservative options. As a result, environmental permits effectively encourage business to adopt existing, familiar end-of-the-pipe pollution control technology. The system discourages technological change by punishing failure much more than it rewards success. The system creates substantial dis-

285. *See, e.g.*, Clean Water Act, 33 U.S.C. § 1342(b)-(c) (1986); Clean Air Act, 42 U.S.C. § 7410 (1994). The Superfund program is the most prominent exception; it does not now authorize such delegation to the states although there have been legislative proposals that it be changed to do so. *See* 42 U.S.C. § 9615 (1994); *see also* Fontaine, *supra* note 6, at 50-51.

incentives to innovative efforts for both regulatory permit writers and businesses.

For permit writers, new technology is both more difficult and riskier to cover with a permit. In theory, it shouldn't make any difference; the permit writer merely specifies the discharge standards to be met and does not specify the requisite technology. However, regulatory agencies do not provide their employees with much technical support in evaluating the likely performance of new technology.[286] Evaluating the new technology thus takes longer, potentially making the permit writer look less productive within the regulatory bureaucracy, particularly those with unduly heavy workloads.[287] In addition, if the new technology does not work perfectly or on time, the permit writer is likely to be associated with the "failure" and subject to the well known internal bureaucratic consequences. It is not surprising that, in the face of these internal incentives, regulators tend to discourage new technology at the permitting stage.[288] The result is a "culture of caution and risk aversion" in environmental permitting.[289]

In this regulatory environment, companies are predictably discouraged from developing and adopting technological changes.[290] Getting a permit for new technology will, even if successful, take longer and require more of an effort to persuade regulators of its feasibility.[291] Of course, the risk that the technology may not work perfectly, or on time, creates a risk of violating the permit when it is issued. The company may consider this a potential cost that more than offsets the potential advantages of-

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286. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275.

287. *See* Heaton, Regulation and Technological Change, *supra* note 17, at 22.

288. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275; ELI, ENVIRONMENTAL TECHNOLOGY VERIFICATION, *supra* note 79, at 10-12, 14-15.

289. *See* ELI, ENVIRONMENTAL TECHNOLOGY VERIFICATION, *supra* note 79, at 14-15.

290. In addition to the incentives created by the permitting system, there are a number of disincentives to technological change typically found in the organization, structure and operations of business corporations. These are discussed *supra* Parts II and III.

291. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 35.

fered by new technology.[292]

Two other, less obvious, disincentives also flow from the regulatory system and business response to it. First, technological change may also change the waste stream itself and thus require new and different permits, even though the new waste stream would doubtless be a net environmental improvement in the total waste stream.[293] Pollution prevention can often involve reuse, recycling, or other in-plant operations with the waste stream, all of which can trigger additional regulatory requirements; in the worst case, these requirements can make prevention more expensive and difficult than simple waste disposal by shipment offsite.[294] The net effect can be additional disincentives to technological change and pollution prevention.

Second, prevention and technological change may be discouraged by the way companies have learned to comply with the ex-

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292. *See* ELI, ENVIRONMENTAL TECHNOLOGY VERIFICATION, *supra* note 79, at 11.

293. For example, CWA will require a new source permit whenever any construction takes place that will result in pollution discharge; construction includes "any placement, assembly, or installation of facilities or equipment". 33 U.S.C. § 1316(a)(2)-(3), (5) (1994). No discharge is allowed except as authorized by one of the provisions of the act. *See id.* § 1311(a). CAA also has broad coverage of new sources, including modifications of existing sources. *See* 42 U.S.C. § 7411(a)(2)-(4) (1994).

294. Under RCRA, a facility that generates hazardous waste must comply with regulations for its storage, handling and disposal; there are special rules for small quantity generators. *See* 42 U.S.C. §§ 6922, 6921(d) (1994) (respectively). Coverage is triggered by whether the wastes are within the statutory and regulatory definitions of hazardous, so changes in the waste stream as a result of prevention activities may well cause or expand a facility's coverage under this provision. *See id.* § 6921. Where there is substantial storage, reuse, recycling or on site treatment of the waste, as there may well be with prevention programs, the company may also be regulated as a treatment, storage and disposal facility, calling forth even more complex regulations. *See id.* § 6924. Coverage is triggered by the functions performed on defined hazardous materials. *See id.* § 6925. The claim is frequently made that RCRA regulation discourages environmental technological change because the change is likely to lead to greater permitting and other regulatory requirements under this most complex scheme. *See* EPA, TRANSFORMING ENVIRONMENTAL PERMITTING, *supra* note 216, at xiii.

isting system.[295] For most medium-sized and large businesses, getting permits and staying in compliance have become specialized activities organized in a specialized environmental compliance unit of a company. This specialization doubtless reflects the expertise needed to comply with the complexity of today's environmental regulation. One result, however, is that these business specialists become expert in the existing system and the existing technology and, in doing so, become deeply committed to maintaining it.[296] The permitting system, the officials who operate it, and especially the end-of-the-pipe technology on which it relies are all familiar. The compliance personnel are less likely to be familiar with the technological changes needed for pollution prevention inside the plant rather than at the end-of-the-pipe. This increases the cost and risks to the firm. The net result is that corporate compliance personnel are more committed to the existing system and its technology, and thus resistant to fundamental changes in it.

Over time, these attitudes become institutionalized within a corporation, leading to a business culture that discourages environmental technological change rather than the innovation oriented corporate culture needed to support pollution prevention.[297] A compliance-deterrence business culture is largely reactive to agency initiative, rather than innovative in its efforts. At its worst, it simply does what the regulator says, gets the per-

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295. *See* EPA, TRANSFORMING ENVIRONMENTAL PERMITTING, *supra* note 216, at 14.

296. *See* 42 U.S.C. §§ 6922, 6921(d), 6925 (1994); EPA, TRANSFORMING ENVIRONMENTAL PERMITTING, *supra* note 216, at 14; *Multimedia Regulation: Facilities To Get A Single Permit for Air, Water, Waste in N.J. Pilot Plan*, 1994 Daily Env't Rep. (BNA), Oct. 19, 1994, at d12.

297. *See* ELI, TOOLS OF PREVENTION, *supra* note 228, at 15; OTA, SERIOUS REDUCTION OF HAZARDOUS WASTE (OTA-ITE-317, 1986). See Cebon, *The Myth of Best Practices*, *in* ENVIRONMENTAL STRATEGY FOR INDUSTRY, *supra* note 17, which distinguishes between waste reduction projects undertaken to achieve permit compliance and those undertaken for their savings potential. While the anticipation of the need for compliance can encourage technological change, a business compliance culture will narrow the range of possible change options considered. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 80-82.

mit, and tries to stay in compliance. From a policy perspective, however, this result is most unfortunate. Prevention usually requires technological change, and only business can know enough about its processes and products to make those changes.[298] Technological change requires a supportive corporate culture,[299] not the reactive compliance-deterrence culture that the present system often engenders.

The most familiar technology is end-of-the-pipe pollution control technology. Both regulators and business compliance officials will know it best. These disincentives will be even more of a problem with a radical innovation, particularly one that requires fundamental product of process changes. Unless the system makes a special effort to encourage change, its inherent incentives push in the opposite direction.[300]

B. *Encouraging Pollution Prevention in Permitting*

Environmental permitting need not discourage pollution prevention. Two distinct kinds of changes in the regulatory system are needed: (1) removing existing disincentives to new technology within the agencies themselves; and (2) reinforcing existing incentives for businesses to create and adopt new prevention technologies.

Each agency must address the risks and rewards, for their own employees, of writing permits for use of new technology and, more broadly, allowing for and supporting technological change. The present system of managing and evaluating permit writers offer neither special support, nor special credit and recognition

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298. *See* Strasser, *supra* note 2, at 3.

299. *See* sources discussed *supra* Part III.A.

300. Unfortunately, this is already illustrated in the poor results of special permitting programs aimed at testing and promoting innovative technology. The special permitting programs have seen little use by business, doubtless reflecting their lukewarm agency support. Creating effective programs would require, at a minimum, substantial restructuring of the agency and business incentives toward special permitting. Beyond this, there are a number of possible policy responses to the problems of the permitting system, several of which are now being discussed and tried.

for doing this difficult job.[301] Permit writers and their supervisors need special training in pollution prevention options and the technological issues they present.[302] Further, special technical backup support for permit writers must be available. Because the focus will be on the inside of the plant, the training and backup support will have to be more industry-specific than has previously been the case. Permit writers are frequently state officials, and the federal role in this area must emphasize supporting them.[303]

In addition, promoting prevention and technological change will require that the agency's internal system of evaluation give permit writers proper credit for the extra efforts required. Evaluating and permitting a successful prevention project should count for more than handling a conventional pollution control project. In addition, the informal and formal internal sanctions for failed projects must be reduced, and with a good faith prevention project, they should be eliminated completely.

A few states have begun to address these problems,[304] although

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301. *See* EPA, BUILDING STATE AND LOCAL POLLUTION PREVENTION PROGRAMS 17-19 (EPA-130-R-93-001, Dec. 1992); EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 35-36.

302. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 64, 85-92.

303. Federal grants to support state activities offer a substantial opportunity to encourage change in permitting programs, but few have done so. There are some prominent exceptions, including Massachusetts and New York. Instead, federal prevention grants tend to emphasize either technical assistance and other voluntary programs, or prevention-oriented compliance and enforcement. The federal grant programs have often provided training for officials involved in the technical assistance and voluntary programs; they are increasingly emphasizing training for state regulatory officials also. *See* EPA, ENCOURAGING STATE INNOVATION: PREVENTING POLLUTION THROUGH GRANT FLEXIBILITY (EPA-100-R-94-003, Spring, 1994); EPA, STATE POLLUTION PREVENTION INITIATIVES UTILIZING MEDIA-PROGRAM GRANT FLEXIBILITY (EPA-100-R-94-001, Mar. 1994).

304. See the discussion of Alaska's efforts to institutionalize pollution prevention thinking in all of its traditional regulatory programs, including permitting, supported by EPA grant funding, in EPA, STATE POLLUTION PREVENTION INITIATIVES, *supra* note 303, at 32. EPA, POLLUTION PREVENTION 1997: A NATIONAL PROGRESS REPORT (EPA 742-R-97-00) briefly discusses additional state programs in Alabama, *id.* at 136, 143,

they are still a decided minority. California has a technology certification program that primarily provides oversight and verification of privately conducted testing.[305] This effort can provide the basis for permit writers to approve the use of new technology. Further, technology certifications by the California program are to be given reciprocal acceptance in Illinois, Massachusetts and New Jersey, while New York and Texas are reported to be considering it.[306]

The Texas Innovative Technology Program, a three-person office within the regulatory agency, establishes a list of innovative technologies and then facilitates their consideration within the permitting process.[307] The program also creates technical review priority for all projects and permit applications that involve innovative technologies.[308]

The Massachusetts STEP program offers expedited technical review and permitting for new technology, as well as coordinating and facilitating its review by other agency staff.[309] The positive incentives programs for business discussed below evidence a growing agency recognition of the difficulties of permitting new technology. Perhaps incentives within the agency will also be more widely addressed in the future.

In contrast to their inattention to internal agency incentives, environmental regulators have begun considering and implementing incentives to businesses in the permitting process. The agencies have used three primary policy tools to encourage business to embrace environmental technological change and pollution prevention: (1) multimedia permitting; (2) direct regulatory rewards in exchange for specified prevention projects; and (3) permit standards requiring prevention efforts.

Ohio and New Jersey, *id.* at 7, 191, and the efforts to evaluate technical assistance programs in North Carolina and Iowa, *id.* at 223.

305. *See* CALIFORNIA ENVTL. PROTECTION AGENCY, ENVIRONMENTAL TECHNOLOGY CERTIFICATION PROGRAM — PROGRAM SUMMARY (Apr. 1995).

306. *See id.*

307. *See* TEXAS NAT. RESOURCES CONSERVATION COMM'N, INNOVATIVE TECHNOLOGY PROGRAM (Aug. 25, 1994).

308. *See id.*

309. The Massachusetts Strategic Envirotechnology Partnership 'Step' An Overview.

The first policy tool, multimedia permitting, is one of the most effective. The difficulty of writing appropriate standards, however, makes this a long-range goal and improvement of permitting need not — and should not — wait for it. A multimedia focus could be used to coordinate permitting under single-medium standards, integrating them as much as possible, to send business a multimedia pollution prevention message.[310] The benefits are widely recognized, particularly the potential long-term environmental gains from promoting prevention and technological development.[311] However, writing multimedia permits will be resource-intensive efforts for regulatory agencies, and agency managers must recognize this.

Several state-level programs are currently being discussed.[312] New Jersey's pilot program is the most advanced and aggressive pollution prevention multimedia permitting effort in existence.[313] This pilot program issued its first single facility-wide multimedia

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310. For a discussion and comparison of the different approaches to multimedia permitting, see Steven Anderson & Jeanne Herb, *Building Pollution Prevention Into Facilitywide Permitting*, POLLUTION PREVENTION REVIEW 415, 418-22 (Autumn 1992). Simply coordinating the issuance of single-medium permits promotes administrative efficiency, although it does not promote prevention as strongly as truly integrated single-facility permitting directed at prevention. *See id.*

311. *See* EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93; EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275.

312. *See* EPA, ENCOURAGING STATE INNOVATION, *supra* note 303; EPA, ONGOING EFFORTS BY STATE REGULATORY AGENCIES TO INTEGRATE POLLUTION PREVENTION INTO THEIR ACTIVITIES (EPA/742/B-93/002, Sept. 1993); EPA, POLLUTION PREVENTION 1997, *supra* note 304, at 23, 139-40, 151 (discussing programs in Massachusetts, Ohio, Illinois, Indiana, Alaska, Idaho, Oregon, Texas and Washington); EPA, STATE POLLUTION PREVENTION INITIATIVES, *supra* note 303; EPA, TRANSFORMING ENVIRONMENTAL PERMITTING, *supra* note 216, at 26-31; Fontaine, *supra* note 6, at 97. A previous EPA effort to adopt integrated permitting made substantial progress in the late 1970s, but ultimately became a casualty to new agency priorities in the change of administration in the 1980's. *See* Fontaine, *supra* note 6, at 94-96.

313. *See* Anderson & Herb, *supra* note 310, at 422-29; *Multimedia Regulation: Facilities to Get a Single Permit for Air, Water, Waste in N.J. Pilot Plan*, *supra* note 296; *see also* N.J. STAT. ANN. § 13:1D-48 (West 1991); Pollution Prevention Program Rules, N.J. ADMIN. CODE tit. 7, §§ 1K-7.1 et. seq. (West 1994).

permit in the fall of 1994 and two more were planned for the spring and summer of 1995, with the total to eventually grow to 15 facilities.[314] Regular reports to the legislature are a specified part of the program.[315] The first permit was issued to the Kenilworth, NJ facility of Schering-Plough; the new single-facility permit replaced approximately 100 different air permits and two water permits that had covered 800 individual sources in thirty-one production processes.[316] This single permit should create very real incentives to prevent or reduce pollution because of the way its requirements were set.

The New Jersey program goes well beyond simply coordinating permitting under existing programs. The program sets standards for individual facilities based on pollution prevention plans that were previously mandated for all facilities.[317] While total emissions in all major categories are to be reduced, decisions about which individual sources will be reduced, and when, is largely up to the company.[318] By giving the company this initiative, the permit's requirements should focus the company's attention on its operating processes that generate pollution, in contrast to the traditional system's tendency to focus on control at the end-of-the-pipe for each individual source. For example, Schering plans to use process modifications and substitutions to eliminate the use of 1,1,1 trichloroethane and substantially reduce use of two chlorofluorocarbons.[319]

The New Jersey program began as a pilot project, working only with self-selected volunteer companies. It has already taught the valuable lesson that writing multimedia permits demands a lot more agency resources, although enforcement should gradually become more efficient. However, the program's most important results will not be its internal agency impact, but its long-term

314. *See* N.J. STAT. ANN. § 13:1D-48(a) (West 1991).

315. *See id.* § 13:1D-48(c).

316. N.J. DEPE, *Facility-Wide Permitting* (Fact Sheet Announcing the Issuance of the First Facility-Wide Permit).

317. *See* EPA, BUILDING STATE AND LOCAL PROGRAMS, *supra* note 301, at 62 (discussing linking permitting to facility planning requirements); Anderson & Herb, *supra* note 310, at 423-24.

318. *See* Anderson & Herb, *supra* note 310, at 423-24.

319. *See* N.J. DEPE, *Facility-Wide Permitting, supra* note 316.

impacts on the company incentives and behavior to develop and adopt new technology and prevent pollution.

Further legislation and rulemaking adopted in the fall of 1995 have greatly extended the pilot program. In August, 1995, new legislation rewrote the state's air pollution control law to authorize widespread use of single air permits for many large facilities.[320] In September, the Department of Environmental Protection issued revised regulations that authorize facility-wide air permits.[321] While the facility-wide permits are for only one medium, air, their widespread use is a major advance. Such facility wide air permits could much more easily be incorporated into future multimedia permitting programs.

The second tool to promote prevention and technological change is a direct regulatory reward offered in the permitting process in exchange for specified prevention projects. Typically, these rewards take the form of expedited consideration of, and action on, permit applications.[322] In addition, some programs offer easier permitting or delayed compliance in exchange for pollution prevention efforts. For example, the Illinois statute authorizes the regulatory agency to accommodate approved pollution prevention plans, through expedited coordination and processing of permit applications, "appropriate" cooperation on variance requests, and technical assistance on potential compliance problems.[323]

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320. *See* N.J. SESS. LAW SERV., ch. 188, Assembly 2664 (West 1995) (amending N.J. STAT. ANN. § 26:2C-1 et. seq. (West 1987)). The legislation defines a facility that must get a permit as "the combination of all structures, buildings, equipment, control apparatus, storage tanks, source operations, and other operations that are located on a single site or on contiguous or adjacent sites and that are under common control of the same person or persons." *Id.* (amending N.J. STAT. ANN. § 26:2C-2).

321. 27 N.J. REG. 3421(a) (amending N.J. ADMIN. CODE tit. 7 §§ 27-22.1 through 22.5, 22.12, 22.16, 22.18, 22.31 and adopting new rules N.J. ADMIN. CODE tit. 7 §§ 27-22.8, 22.20 through 22.26, 22.28A, 22.28B, 22.30, 22.33, 22.34, 7:27.22 app. I).

322. *See, e.g.*, the Texas and Massachusetts programs described in text accompanying *supra* notes 307 and 309 respectively.

323. Illinois Toxic Pollution Prevention Act, ILL. ANN. STAT. ch. 415, para. 85, § 6(c)(1)-(3) (1990).

However, the accommodation is limited "[t]o the extent feasible under applicable law and consistent with prudent environmental practices. . . ."[324] Moreover, such accommodations have not been reported to be either widely sought or frequently given.[325] In the one reported application, LaClede Steel planned a new technology for on-site recycling of a hazardous waste stream. It sought air permitting assistance and a waiver of RCRA land-ban provisions to support the new technology.[326] Illinois neither approved nor denied the regulatory assistance sought and Region V of EPA ultimately sued on the RCRA violation after the new technology was adopted.[327] The result sent a clear message to business discouraging pollution prevention and technological change, despite the statutory authorization of regulatory accommodation.

The 1990 Amendments to the Clean Air Act, in changing the regulatory approach to air toxics, offer substantial permitting incentives in exchange for early reduction of emissions.[328] The core regulatory program was changed to set the emissions standards for airborne toxics with reference to maximum achievable control technology (MACT).[329] These new standards are to be written by EPA over a ten year period.[330] However, sources that agree to a ninety percent reduction of their discharge of the toxics in question can qualify for a six year delay in application of the new MACT standards.[331] Companies could have qualified either

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324. *Id.* § 6(c).

325. Texas also authorizes permit variance and expedited application review for prevention projects. WRITAR, STATE LEGISLATION RELATING TO POLLUTION PREVENTION 65 (Mar. 1994). Michigan authorizes its Office of Waste Reduction to identify ways to encourage waste reduction through permit programs. *See id.* at 38.

326. *See* EPA, PROVIDING WAIVERS, *supra* note 257, at 40-41.

327. *See id.* at 41. "The case appears to provide an example of the difficulty posed by the relationships of state and federal legislative and regulatory requirements in efforts to promote innovation waivers at the state level." *Id.*

328. 42 U.S.C. § 7412 (1994).

329. *See id.*

330. *See id.* § 7412(e).

331. *See id.* § 7412(I)(5) (reduction must be 95 percent for particulate toxics).

by making the reductions prior to proposal of the MACT standard, or by making an enforceable commitment to achieve the reduction by January 1, 1994, even if the standard had already been proposed.[332] Reductions had to be made below emissions provable under a 1987 baseline.[333]

This permit waiver has the potential to promote earlier reductions than would otherwise be required. From a pollution prevention standpoint, it also can provide permitting recognition to reductions that have been made previously, beyond what had been required, as long as these could be proven.[334] The delay in meeting new emissions standards could also be used to pursue more fundamental technology changes without the immediate threat of non-compliance, assuming the ninety percent reduction requirements could be met.

Unfortunately, this program has had only limited impact. The EPA Office of Air Quality Planning and Standards reports that as of September, 1995, there had been ninety-three enquiries, of which twenty-seven became actual applications; of these, seventeen were completed, eight still incomplete, and two withdrawn.[335] One of the major reasons for this limited use was the difficulty of compiling base-year data. One facility stated that over 900 staff hours would be needed to put the data together in the form EPA required.[336] Determining the baseline of emissions is an important implementation issue in any early reduction

332. *See id.* § 7412(I)(5)(B).

333. *See id.* § 7412(I)(5)(C).

334. *See* Ronald Begley & Ken Cottrill, *Rules' Paperwork Burden Weighs Down on Industry*, CHEM. WK., Nov. 3, 1993, at 24 (discussing Monsanto's voluntary early reductions program that has achieved more than 90 percent reductions worldwide). Such a program that could prove reductions from a specific source would provide the basis for the six year delay under this provision. *See id.*

335. Conversation with Mr. Rick Collier, EPA Off. Air Quality Plan. & Standards, Jan. 28, 1997. Other sources have reported varying numbers of applications. As of Sept. 1994, the GAO reported 40 active applications and 12 approvals. *See* GAO, TOXIC SUBSTANCES: STATUS OF EPA'S EFFORTS TO REDUCE TOXIC RELEASES 8-10 (GAO/RCED-94-207, Sept. 1994).

336. *See* GAO, TOXIC SUBSTANCES: STATUS, *supra* note 335, at 9.

credit program.[337] Without careful attention to the baseline, the reductions may not be real ones. However, detailed proof of emissions that were unregulated at the time of discharge may be difficult, and requiring too much precision may make the program unworkable for many potential participants. Other reasons for the air toxics program's failure to attract many participants include the uncertainty of the status of early reductions under state law, the delay in issuing federal regulations for the program, and the cost of pollution control equipment that might meet legal requirements for only a limited time.[338]

The third policy tool is permit standards that require direct prevention, and can be set to require specific prevention results.[339] These provisions could be used to require particular prevention projects, although they have not been so used before and thus have not had judicial interpretation of their outer limits. In 1993 it was reported that a number of states were considering the incorporation of specific pollution prevention requirements in individual permits.[340] Direct requirements under either state or federal programs could have a positive impact in mandating diffusion of existing technology by otherwise reluctant companies. Such requirements seem less likely to support more innovative efforts since they are more difficult to identify and command in the permitting process.

New Jersey law has recently incorporated a similar requirement for new air pollution permits.[341] That legislation requires that:

> Newly constructed, reconstructed, or modified equipment and control apparatus shall incorporate advances in the art of air pollution control as developed for the kind and amount of air

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337. *See id.*

338. *See id.*

339. *See* discussion *supra* Part III.F. For example, water permit standards can be set individually, with reference to best management practices, or they can sometimes mandate zero discharge if this is technologically possible. The requirement that hazardous waste disposers have a waste minimization plan, although now only nominal, could be rigorously enforced.

340. EPA, ONGOING EFFORTS BY STATE REGULATORY AGENCIES, *supra* note 312, at 6, presents a summary chart of specific state efforts.

341. *See* N.J. SESS. LAW SERV., ch. 188, Assembly No. 2664 (West 1995) (amending N.J. STAT. ANN. § 26:2C-9.2(c) (West 1993)).

> contaminant emitted by the applicant's equipment and control apparatus as provided in this subsection.[342]

Implementing regulations will issue general permits, defining the state of the art "by reference to Federal standards, when applicable, and by publishing technical manuals," and de-emphasize the need for case-by-case reviews except for the most complex sources.[343] The success of these new permitting regulations in defining the state of the art would support diffusion of the latest cleanup technology. However, past experience by other regulatory agencies does not inspire confidence that permitting regulations will often succeed in truly demanding the state of the art. Without doing so, the new approach is unlikely to actually push many sources to the cutting edge. It is even more unlikely to spark the business initiative and creativity that true innovation requires to advance the state of the art. Some diffusion of existing technology among previously laggard or resistant sources may well result, but innovation will probably not be spurred.

In addition to these three specific strategies, three EPA-sponsored collaborative efforts with business have offered permitting improvements. All three efforts center on forming industry specific collaborative efforts to pursue improved environmental management. Each effort will likely include improvements to the permit system that should make it more friendly to technological change and pollution prevention.

As discussed in Part III.F above, the Common Sense Initiative aims to analyze and improve environmental regulation by looking at specific industry sectors.[344] Initially, six sectors have been selected for attention.[345] The first step is to assemble broad-based discussion groups for each sector, including representatives from business, regulatory agencies, labor unions, environmental groups and other public interest organizations.[346] These sector groups are directed to consider improvements in permitting and five other specified aspects of the regulatory system.[347] As of June, 1997, EPA reported forty ongoing projects with 150 active

342. *Id.*
343. N.J. REG. 3421(a) (1995).
344. *See* EPA, COMMON SENSE INITIATIVE, *supra* note 208, at 3-4.
345. *See id.*
346. *See id.* at 3.
347. *See id.* at 3-4.

stakeholder participants.[348] Regulatory improvements, including multimedia permitting consideration, are being discussed in the Iron and Steel and the Printing working groups.[349] Further, all six groups are considering regulatory alternatives to the present permitting and compliance monitoring system.[350]

The second EPA effort, the Permits Improvement Team, is also in its early stages.[351] It was formed in July, 1994, in response to the present permitting system and the Vice President's and EPA's reform suggestions.[352] In the first round of discussions, pollution prevention was embraced as a goal, although multimedia permitting and support for new environmental technology were given less prominence.[353] In contrast with the Common Sense Initiative, the PIT is concerned with general environmental permitting, across many industry sectors.[354] One of the CSI industries is

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348. *See* EPA, COMMON SENSE INITIATIVE UPDATE (June 1997), *supra* note 211.

349. *See* EPA, COMMON SENSE INITIATIVE, *supra* note 208, at 17-20.

350. *See* EPA, COMMON SENSE UPDATE (Aug. 1995), *supra* note 211, at 3-4.

351. *See* EPA, PERMIT IMPROVEMENT TEAM NATIONAL STAKEHOLDER MEETING REPORT 1 (EPA 500-R-95-002, Jan. 1995).

352. *See id.*; EPA PERMITS IMPROVEMENT TEAM, FINAL DRAFT OF CONCEPT PAPER ON ENVIRONMENTAL PERMITTING AND TASK FORCE RECOMMENDATION (July 1996).

353. *See* EPA, PERMIT IMPROVEMENT TEAM, *supra* note 351, at 27. Focus group discussions offered strong support for pollution prevention. *See id.* Concerning innovative technology, the report found:

> *Innovative Technology* — Overall, the focus groups were supportive of and interested in the idea of regulatory agencies promoting the use of innovative technology. There were, however, many more questions and cautions offered than specific outcomes or outputs.

Id. at 26. The difficulty of implementing a multimedia perspective was also noted:

> *Implement a Cross Media Perspective* — Overall, the focus group believed this should be a low priority given the difficulty of implementing such a system. It was recognized that laws are media specific. Pitfalls include potential conflict with varying state regulatory structures and goals, the possibility for over permitting . . . and the tremendous amount of resources that would need to be devoted to such an effort.

Id. at 24.

354. *See id.* at 7.

expected to be a pilot project for implementing specific PTI recommendations.[355]

The third program is Project XL.[356] It follows several preliminary proposals for alternative permitting processes for selected volunteer companies. The core idea is to accept a company's commitment to achieve standards above those required by law, in exchange for flexibility in meeting those commitments.[357] If properly implemented, alternative permitting would direct business' attention inside the plant, to redesigning products, raw materials, and processes which will create less waste in the first place. Providing the company with flexibility is essential if it is to rely on business initiative and creativity.[358]

However, that very flexibility also creates real implementation concerns. While any approved plan will doubtless offer environmental protection benefits, it may also allow behavior that violates the existing regulatory regime. Indeed, such violations may well be the source of the flexibility. However, so long as the plan is being implemented EPA will abstain from enforcement actions.[359] Cooperation from state enforcement officials in pursuing

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355. *See id.*

356. Project XL is described in Solicitation of Proposals and Request for Comment, 60 Fed. Reg. 27,282-27, 27,291 (May 23, 1995). It seeks to identify and support specific industrial facility proposals. For example, 3M has proposed a multimedia emissions cap and reduction plan, in exchange for flexible permitting and compliance monitoring, at three specific industrial facilities. *See* EPA, PROJECT XL PROPOSALS FOR FACILITIES, SECTORS, AND GOVERNMENT AGENCIES (Aug. 28, 1995); EPA, XL PROJECTS FOR FACILITIES, SECTORS, AND GOVERNMENT AGENCIES ACCEPTED FOR DEVELOPMENT OF FINAL PROJECT AGREEMENT (Jan. 25, 1996) <http://www.epa.gov/ProjectXL/xl_proj2.html>; sources cited *supra* note 213.

Several business and other proposals are summarized and sources are cited in William F. Pedersen, *Can Site-Specific Pollution Control Plans Furnish an Alternative to the Current Regulatory System and a Bridge to a New One?*, 25 ENVTL. L. REP. 10,486 (Sept. 1995).

357. *See* Solicitation of Proposals and Request for Comment, 60 Fed. Reg. at 27,283.

358. *See* Pedersen, *supra* note 356, at 10,486. Without such flexibility, such a plan could simply reinforce the worst features of our present regulatory system and also discourage pollution prevention.

359. Memorandum from Steve Herman, Assistant Admin., Off. Enforcement & Compliance Assurance, Operating Principles for Project XL Participants (Oct. 2, 1995).

the same policy will be crucial.

There are a number of important administrative concerns with the implementation of this plan. Negotiating the agreement and monitoring the performance would doubtless require additional agency resources. Further, since the internal agency pollution control culture has not been hospitable to other pilot projects that depended on exceptions negotiated with individual sources, agency managers must address the extra institutional support that is necessary for this program. In addition, the increased need for company resources make it likely that this system would be utilized more often by large rather than small facilities.

A provision for public involvement is essential for instilling credibility in this program. Beyond this, the plan must allow for changes in company operations that change its waste streams. In addition, the plan must also make some provision for new environmental protection needs that emerge from new knowledge of health or ecosystem effects of pollution discharges.

Despite these concerns, such a system should be pursued because it does have great potential to encourage pollution prevention and technological change by business. Project XL is still in its infancy and predictions regarding its ultimate success are not possible. The history of failed, abandoned or ultimately ignored pilot projects and other alternative regulatory initiatives cast a long shadow over it. Yet its potential for motivating business to better environmental protection performance is real and should be developed.[360]

The recently adopted New Jersey air pollution legislation authorizes its regulatory agency to negotiate alternative permitting. The agency can, by regulation, "offer a person the option of establishing in an operating permit a 15-year plan for reducing facility emissions beyond minimum air pollution control requirements in lieu of adhering to strict permit review schedules and complying with less effective State requirements."[361] The plan must include schedules and milestones and the department must

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360. For a discussion and preliminary evaluation of Project XL, see NAPA, RESOLVING THE PARADOX, *supra* note 213, at 11-17; Jody Freeman, *Collaborative Governance in the Administrative State*, 45 UCLA L. REV. 1, 55-66 (1997).

361. *See* N.J. SESS. LAW SERV. ch. 188, § 13, Assembly 2664 (West 1995) (amending N.J. STAT. ANN. § 26:2C-9.2(3)(a) (West 1987)).

review these every five years.[362] The plan may include the option of permits that reduce the de minimis modification requirements of equipment and control apparatus that make only de minimis increases in allowable emissions.[363] While such a plan could certainly ease administrative compliance burdens, its greatest benefit could be the flexibility and time it affords business to consider, develop, test and implement fundamental changes in equipment, processes and products. Such technology changes offer the greatest opportunity for pollution prevention success over the long term.

In sum, the permitting process now often works to discourage prevention, but it need not do so. Current policy thinking, as well as pilot projects and demonstration efforts, are addressing the disincentives for business in the system. However, internal incentives within regulatory agencies must also be addressed, having received insufficient attention thus far.

V. COMPLIANCE, ENFORCEMENT AND TECHNOLOGICAL CHANGE

A. *The Bias Against Technological Change in Traditional Compliance and Enforcement*

The last stage of traditional environmental protection regulation is compliance and enforcement: ensuring that companies get individual permits and meet their requirements. These compliance and enforcement processes are interrelated and sequential. Regulatory compliance activities monitor environmental performance of individual sources, inspect facilities, and seek to negotiate necessary improvements. Much of the activity is premised on the idea that many pollution generators will comply with regulatory requirements if they understand what is demanded and are given some assistance in compliance. Technical assistance is a natural outgrowth of compliance efforts, although offering it does present problematic questions regarding the role of regulatory officials if enforcement becomes necessary. Enforcement follows unsuccessful compliance efforts; it uses the implicit and explicit threat to employ legal machinery to order compliance and seek penalties for noncompliance. Enforcement efforts

362. *See id.* at 1219.
363. *See id.*

typically begin with negotiation and can become increasingly formal and adversarial if negotiation is unsuccessful.

Compliance and enforcement activities are concerned with potential violations of the law that can lead to very real sanctions. The threat of being branded a lawbreaker, plus the possibility of legal sanctions, may motivate pollution prevention activities: a so-called "teachable moment."[364] The anticipation of enforcement is a powerful motivation for business to respond to environmental regulation.[365] These threats are difficult to ignore, and they could be used to motivate some types of pollution prevention efforts.

In compliance and enforcement, both regulators and companies have traditionally gravitated to the use of familiar pollution control technology, although for different reasons. With potential violations of law at stake, regulators have been particularly unwilling to run the risks of delay and failure that are always present to some degree with new technology. Regulators are understandably reluctant to permit or approve new technologies that may continue, or even possibly worsen, violations of legally established standards. As the process moves from compliance monitoring to formal enforcement, the process inevitably takes an adversarial tone and regulators demand certainty that technical solutions will work so that violations will be cured.

Companies also have reason to gravitate toward familiar technology and known solutions in the compliance/enforcement process. For the company, the risks of compliance failure entail both legal sanctions and substantial public disapproval. These risks may also affect employees charged with supervising the company's compliance. The regulatory process is now so complex that compliance is typically entrusted to a specialized office within medium-sized and large companies. The result is the compliance mindset; known technology and familiar solutions insure compliance that protects both the company and employees from sanctions.[366] The best-developed environmental technology is

364. *See* EPA, BUILDING STATE AND LOCAL PROGRAMS, *supra* note 301, at 64.

365. *See* Ashford et al., *Using Regulation, supra* note 3; EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 12.

366. *See* EPA, TRANSFORMING ENVIRONMENTAL PERMITTING, *supra* note 216, at 22-23; Ashford, *Innovation Based Strategy, supra* note 1, at 275-77.

end-of-the-pipe pollution control equipment and know-how.[367] This is what the system has been emphasizing and requiring for more than twenty years and, not surprisingly, this is what has been developed and delivered. The result is a real, if unintended, bias against prevention and technological change.

In addition to these disincentives, the time required to develop and implement new technology for pollution prevention limits its use in compliance and enforcement. Changes in the basic manufacturing process, the raw materials, or the product take time to conceive, design, and test. However, from a regulatory point of view, all this time is a period of actual or potential noncompliance with legal commands: an unacceptable delay. Thus, regulators are virtually certain to demand that a particular business response to compliance and enforcement efforts be definite and prompt — demands that will discourage fundamental innovations even though they offer potentially the most dramatic pollution prevention successes.

Diffusion of existing technology, rather than development of more radical innovations, requires less time and provides more certainty. This is probably the best support of new technology that one can realistically hope for in the compliance and enforcement process. Even this limited support offers quite substantial progress on pollution prevention. As the case studies and other evaluations show, there is quite a lot a prevention potential in technology diffusion;[368] achieving it through the compliance/enforcement process would be a substantial environmental protection gain.

Monsanto Co. v. EPA[369] offers a clear illustration of regulators' preference for familiar end-of-the-pipe technology and its discouraging impact on pollution prevention and new technology. EPA had issued new regulations requiring removal of ninety-five percent of the benzene from a number of sources including

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367. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 20.

368. *See* EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93, at 19-21. For citations to case studies of pollution prevention, see Strasser, *supra* note 2, at 9 n.28.

369. 19 F.3d 1201 (7th Cir. 1994).

Monsanto's monochlorobenzene manufacturing facility.[370] The traditional and familiar end-of-the-pipe technology for this problem was carbon adsorption; it was less attractive because it generated a hazardous waste that required treatment and storage.[371] Monsanto chose an alternative technology, water scrubbing, because it allowed recovery and reuse of the benzene and did not generate hazardous waste.[372] Water scrubbing had worked well in tests, achieving ninety-nine percent reduction, but when installed it accomplished only an eighty percent reduction.[373] Monsanto then had to add a smaller supplementary adsorption system to bring performance up to the required ninety-five percent reduction.[374]

Compliance with the regulation was required ninety days after the regulation was issued, although the EPA administrator was authorized to waive compliance requirements for up to two years if necessary for the installation of controls.[375] An eleven month waiver was granted for initial installation of the water scrubbing system, but the Administrator denied an additional waiver for installation of the supplementary carbon absorption system.[376] The agency reasoned that, since the traditional end-of-the-pipe carbon absorption system could have been installed within the waiver period, an additional waiver was not merited.[377]

Such agency thinking is completely consistent with a pollution control mindset that emphasizes end-of-the-pipe technology, and it misses the opportunity to support pollution prevention through technology development. The court found the agency's action arbitrary and capricious, and reasoned:

> In other words, EPA seems to be saying that if a "quick fix" is available, sources are required to employ that "quick fix" without regard to its adverse environmental ramifications. This view-

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370. *See id.* at 1203.
371. *See id.* at 1205.
372. *See id.* at 1204-05.
373. *See id.* at 1205.
374. *See id.* at 1207.
375. *See* 42 U.S.C. § 7412(c)(1)(B)(ii) (1994).
376. *See Monsanto*, 19 F.3d at 1207.
377. The court found the agency's conclusion that the absorption system could have been installed in this time not supported by the facts. *See id.*

> point is short-sighted and bad environmental policy. Instead of eliminating an environmental problem, the EPA's "quick fix" would merely change the form of the problem — i.e., it would remove the environmental hazard from the air but create a hazardous waste disposal problem.[378]

EPA's approach places all the risk of imperfect initial performance of new technology on the company, which sends an unambiguous message to business. Here the court reversed the agency's poor environmental policy, perhaps blunting the agency's message to a degree.[379] However, one must still wonder if most business people will be willing to take this risk, and incur the expense and delay of pursuing pollution prevention.

While these disincentives and limitations are considerable, there is some basis for guarded optimism. At both the state and federal levels, a number of pilot programs and individual program policies are beginning to create incentives for diffusion of new technology and pollution prevention in the regulatory system.

B. *Recent Efforts to Support Prevention in Compliance and Enforcement*

At both the federal and state levels there is a growing appreciation of the idea that compliance and enforcement policies can be used to encourage pollution prevention and technological change. While most of the specific programs and initiatives to be discussed here are still pilot programs or other one-shot efforts, their number and scope should support deeper institutionalizing of the underlying policy ideas.

Four principal groups of projects and policy ideas are currently in use. First, many states are considering multimedia compliance and enforcement and a few are implementing it. There has been some substantial change in the organizational structural at EPA. In addition, many states now offer technical assistance programs and a multimedia approach is a natural complement to these programs. Second, enforcement officials are increasingly negotiating penalty reductions in exchange for specific pollution prevention activities. These so-called supplemental environmental

378. *Id.* at 1206.
379. *See id.* at 1208.

projects (SEPs) are potentially quite supportive of pollution prevention and technology diffusion efforts, although they have other policy goals and bases as well. Third, the widespread discussion of technology training and support of front-line regulatory personnel is a moderately encouraging sign that regulators are addressing institutional resistance to prevention. Finally, some of the proposals and pilot projects for alternative environmental regulatory and management schemes offer direct regulatory benefits, often allowing companies to avoid onerous inspections, in exchange for pollution prevention and other improved environmental performance.

As discussed above, a multimedia regulatory approach promotes prevention and technological change by directing the company's attention to the processes, materials and products that generate pollution in the first place. In compliance and enforcement, this can be particularly effective, coming as it does with the threat of sanctions. Further, multimedia regulation may be cheaper and easier in compliance and enforcement than in other parts of regulation.[380] Two states, Massachusetts and New York, have made substantial progress in implementing multimedia compliance and enforcement and others are moving in this direction, all with EPA grant support and help.[381]

Massachusetts began one of the first such efforts with the Blackstone project in 1988.[382] In this pilot program the state's Office of Technical Assistance aided polluting companies in creating and implementing prevention projects. The program also in-

380. *See* Fontaine, *supra* note 6, at 50-51. "The enforcement of pollution standards in the U.S. is primarily conducted by the states, as most environmental protection statutes allow the EPA to authorize the states to enforce federal environmental laws if their programs are equally stringent." *Id.*

381. See EPA, ONGOING EFFORTS BY STATE REGULATORY AGENCIES TO INTEGRATE POLLUTION PREVENTION INTO THEIR ACTIVITIES, *supra* note 312, at 6, for a chart summarizing state regulatory programs aimed at pollution prevention.

382. *See* EPA, STATE POLLUTION PREVENTION INITIATIVES, *supra* note 303, at 13-19; EPA, ENCOURAGING STATE INNOVATION, *supra* note 303, at 7-8. For a general discussion of state programs and the issues presented, see EPA, BUILDING STATE AND LOCAL PROGRAMS, *supra* note 301, at 64-67.

voked coordinated multimedia inspections of the targeted companies and these revealed many problems that a single-media approach would have missed.[383] The Blackstone Project, in a Phase II reinspection of twenty-seven of the original twenty-eight facilities, found that twenty-three had undertaken toxic use reduction and waste prevention measures.[384] This project was expanded under a 1991 Ford Foundation grant. Since 1995, facility-wide multimedia inspections have been standard compliance practice for all manufacturing and industrial facilities in the state.[385] However, the resource demands of program development, personnel training, and more extensive multimedia inspections, while not yet quantified, are substantial.[386]

New York has also initiated a program of multimedia compliance inspections and enforcement.[387] The program targets forty-nine high priority facilities.

> For each of the forty-nine facilities designated, the region selects a facility coordinator and a multimedia team. . . . The teams will then design and carry out comprehensive, in-depth multimedia inspections. DEC [New York Department of Environmental Control] is developing training for inspectors so that they are broadly educated in the other media for which they have not previously been responsible. Inspectors will be acquainted with pollution prevention planning requirements so that they can review facility plans stored on-site as part of their inspections.[388]

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383. *See* Fontaine, *supra* note 6, at 69. "The coordinated approach unearthed sixteen violations and five other problems that would have gone unnoticed in a single-media inspection." *Id.*

384. *See* Manik Roy & Lee Dillard, *Toxic Use Reduction in Massachusetts: The Blackstone Project*, 40 J. AIR & WASTE MGMT. ASS'N 1368, 1370 (1990).

385. *See* Fontaine, *supra* note 6, at 14.

386. *See id.* at 19. In developing the program, "[m]any senior inspectors, for example, have been spending 20% of their time on the process, which takes effort away from their standard activities." *Id.*

387. *See* EPA, OFF. PREVENTION, PESTICIDES & TOXIC SUBSTANCES, ONGOING EFFORTS BY STATE REGULATORY AGENCIES TO INTEGRATE POLLUTION PREVENTION INTO THEIR ACTIVITIES 14 (EPA/742/B-93/002, 1993); Fontaine, *supra* note 6, at 20-26.

388. Fontaine, *supra* note 6, at 23.

Ideally, the program will eventually cover the 400 facilities responsible for ninety-five percent of the toxics discharged in New York.[389]

Critical to both the Massachusetts and New York programs have been EPA media grants which support the states' administration of federal laws and regulations.[390] The grant programs set their own compliance and enforcement priorities and they have traditionally emphasized media specific enforcement.[391] In both Massachusetts and New York, however, EPA was willing to adjust the specific requirements of individual medium-specific grants to the priorities required by a multimedia approach.[392] This flexibility is new and commendable. However, widespread adoption of a multimedia approach by the states would make such individually negotiated exceptions a cumbersome process. Federal grant support for multimedia pollution prevention efforts should become general practice rather than an exceptional circumstance. In response to this need, EPA has announced a new program of negotiating more flexible grants to states. As of June, 1997, six states had signed pilot agreements and approximately thirty were involved in negotiations.[393] Such agreements have tremendous po-

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389. *See* EPA, ENCOURAGING STATE INNOVATION, *supra* note 303, at 9.

390. *See id.* at 1-3, 7-10.

391. *See generally* EPA, ENCOURAGING STATE INNOVATION, *supra* note 303; EPA, POLLUTION PREVENTION MEDIA GRANT GUIDANCE (EPA-100-B-93-003, Apr. 1993). *See also* Fontaine, *supra* note 6, at 54 nn.117-20.

> The system for allocating resources to the states, including the negotiation and tracking of grant commitments, is generally perceived to be a barrier to multimedia approaches. Federal program funds to state air, water, and solid waste programs are administratively and legally separate. Funding cycles, accounting procedures, planning and information requirements, and other administrative aspects of these programs are also separate and distinct. Even the states that actively pursued environmental program integration in the 1970's were frustrated by EPA's programmatic structure.

Id. at 54.

392. *See* EPA, ENCOURAGING STATE INNOVATION, *supra* note 303, at 7-10; EPA, STATE POLLUTION PREVENTION INITIATIVES, *supra* note 303, at 15-17, 21-24 (describing the negotiations and the specific terms agreed to).

393. *See* EPA, POLLUTION PREVENTION 1997, *supra* note 304, at 24.

tential, although they require that EPA be willing to actually loosen its degree of control over the states.

In addition to supporting the multimedia efforts of the states, EPA's Office of Compliance has been reorganized in a way that should directly support pollution prevention. The office is now organized by industry sectors, rather than environmental media, with one division devoted to planning, targeting and data.[394] This reorganization is a conscious attempt to move away from the traditional media-specific emphasis and place all compliance issues related to an industry sector in a staff unit specializing in that sector. As a result, the staff should become more expert in the compliance and non-compliance performance of that sector, as well as the technical possibilities and obstacles.[395]

Multimedia compliance programs lend themselves naturally to technical assistance efforts. While many states have substantial technical assistance programs now,[396] most of these were created as independent pollution prevention programs, rather than as part of a compliance program reform. However, these programs can be mutually reinforcing in promoting prevention. Multimedia compliance encourages agencies to develop expertise in specific industries and facilities. It also focuses business' attention on the creation of pollutants inside the plant, rather than their control at the end-of-the-pipe. Thus, both regulator and company can appreciate the importance of technological change, and a technical support program can offer it.

Technical assistance in the compliance process does present some specific concerns. First, is the inspector's role primarily law enforcement, or support for prevention? Typically, the former

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394. *See* EPA, OFF. ENFORCEMENT & COMPLIANCE ASSURANCE, AN INTRODUCTORY GUIDE (EPA 300-F-95-002, Jan. 1995); Michael D. Barrette, *Design and Implementation of Multimedia and Sector Strategies at EPA*, J. ENVTL. REG., Aug. 1995, at 1.

395. *See* EPA, AN INTRODUCTORY GUIDE, *supra* note 386, at 5. To support this sector specific multimedia compliance effort, the Office of Compliance has prepared 18 specific notebooks each describing a particular industry sector. *See, e.g.*, EPA, PROFILE OF THE FABRICATED METAL PRODUCTS INDUSTRY (EPA 310-R-95-007, Sept. 1995). In addition to describing the industry, these notebooks survey the industry's waste creation and disposal issues and discuss pollution prevention possibilities. *See id.* They should prove invaluable technical support for sector specific multimedia efforts by state and federal regulators.

396. *See* WRITAR, STATE LEGISLATION, *supra* note 325.

role is chosen, and reference is made to a separate office that provides assistance.[397] Second, if a company implements the technical assistance suggested, will this significantly lessen its liability for violations? This would be a powerful motivator, but to date it has not been used. It would strongly encourage business to consider prevention opportunities that might be overlooked otherwise. However, it also places the technical and decision-making initiative outside the company, making the company less likely to change its internal culture to embrace prevention.[398]

Enforcement offers the opportunity to create pressure for prevention and technological change, but it also presents special difficulties for a multimedia approach. Enforcement punishes wrongdoing and the penalties imposed must communicate the messages clearly. Coordinating penalties across media is possible, where the statute or rule grants sufficient prosecutorial discretion, but it is not a simple matter even then.

During its long history of proposals and pilot projects, EPA was not successful in institutionalizing multimedia enforcement.[399] Its media-based organization and traditional separations between program offices have resulted in little coordination to achieve multimedia objectives.[400] A review in 1993 concluded that "progress toward integrated enforcement has largely been frustrated by EPA's fragmented organizational structure and programmatic

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397. *Id.* at 51-56.

398. See Strasser, *supra* note 2, at 17-25 for discussion of successful programs.

399. *See* Fontaine, *supra* note 6, at 35-38.

400. *See id.* at 50.

> Although outsiders may view the EPA as a single agency with the unitary purpose of protecting public health and the environment, the organizational structure and individualistic culture have produced separate program offices, each with its own parochial agenda. The Office of Water implements regulations to safeguard the public health and the aquatic environment from the dangers of water pollution. Similarly, the Office of Air and Radiation is concerned primarily with the threat of air pollution. From the standpoint of the EPA's regulated community, interaction with the Agency is on a program-specific basis since industrial facilities are often regulated by a number of separate, and to a large extent, independent, EPA programs.

Id.

inflexibility . . . ."[401] That study's call for recreation of a centralized enforcement office for all the media specific programs has since been heeded. In addition, the Office of Compliance has been reorganized along industry sector lines, although the Office of Enforcement has not.

EPA has had some success with so-called Supplemental Environmental Projects ("SEPs") which supplement the negotiated penalty provision of an enforcement action.[402] In broad outline, SEPs are agreements by companies to undertake a specified project that benefits the environment, in exchange for a reduction in the penalty.[403] SEPs were first authorized in 1991[404] and have recently been revised.[405] Qualifying SEPs are "environmentally beneficial projects which a defendant/respondent agrees to undertake in settlement of an enforcement action, but which the defendant/respondent is not otherwise legally required to perform."[406] Projects that the defendant will be obligated to perform two years or more in the future can also qualify. Pollution prevention projects and pollution reduction projects at the end-of-the-pipe are both covered under the policy.[407]

The policy has two principal restrictions on the types of projects that qualify. First, there must be a relationship between the project and the violation — the "nexus" requirement.[408]

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401. *Id.* at 37.

402. *See id.* at 36.

403. *See id.*

404. Policy on the Use of Supplemental Environmental Projects in EPA Settlements, Memorandum from James M. Strock, Assistant Adm'r, Feb. 12, 1991 (hereinafter 1991 SEP Policy). For a brief review of the policy, see Fontaine, *supra* note 6, at 36-37 & nn.170-76.

405. Interim Revised EPA Supplemental Environmental Projects Policy Issued Wednesday, May 10, 1995, 60 Fed. Reg. 24,856 (May 10, 1995) (hereinafter 1995 SEP Policy).

406. *See id.* at 24,857.

407. *See id.* at 24,858. The other types of projects are public health, environmental restoration and protection, assessments and audits, environmental compliance promotion, and emergency planning and preparedness. *See id.*

408. "This relationship exists only if the project remediates or reduces the probable overall environmental or public health impacts or risks to which the violation at issue contributes, or if the project is designed to reduce the likelihood that similar violations will occur in the future." *Id.* Several other requirements specify that the project must ad-

While one might question exclusion of unrelated projects that offer equal or greater environmental benefits, the restriction eliminates the need for abstract tradeoff determinations between penalty reductions and the relative environmental benefits of such projects.[409] Second, a proposed SEP project that shows a positive cash flow, under EPA's evaluation model, does not qualify.[410] Although this limitation is understandable from a law enforcement point of view, it sends business a most unfortunate message about the potential value of pollution prevention. Under the policy, only costly projects will qualify, so business will not be encouraged to find and propose the most efficient ones. Further, by emphasizing that prevention projects must be costly, this policy may well discourage that change in corporate culture needed to institutionalize pollution prevention programs. While prevention projects are frequently attractive financial investments, this is not a reason to discourage business from pursuing them. To the contrary, encouraging profitable projects can support growth and development of ongoing pollution prevention programs. In addition, this policy requires accurate prediction and measurement of the financial benefits and costs, although this may be difficult with truly innovative projects.

The EPA policy requires calculation of the net after-tax cost of the project, and this cost is then used to determine the amount of penalty mitigation.[411] Of the specific factors that are to be considered in determining the mitigation percentage, pollution prevention, innovativeness, and multimedia impacts are specifically listed.[412] The policy specifies that the mitigation percentage

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vance one of the objectives of the environmental statute being enforced; that EPA cannot play a role in managing or controlling funds used for the project; that the project may not be something EPA itself is required to do; and that the type and scope of the project must be determined in the settlement agreement. *See id.*

409. *See id.* Other acceptable types of projects are public health, environmental compliance promotion, and emergency planning and preparedness. *See id.*

410. "While EPA encourages companies to undertake environmentally beneficial projects that are economically profitable, EPA does not believe violators should receive a bonus in the form of penalty mitigation to undertake such projects as part of an enforcement action." *Id.* at 24,861.

411. *See id.* at 24,857.

412. *See id.* at 24,861. The other factors are benefits to the public

should not, as a general guideline, exceed eighty percent, although it can be as high as 100% for pollution prevention projects. This is robust support of pollution prevention, and a considerably higher percentage than has been reported in agency evaluations of SEPs used.[413]

In 1992, SEPs were used in 160 administrative complaints under these statutes; source reduction accounted for thirty-two percent of these and waste minimization (at the end-of-the-pipe) another thirteen percent.[414] Eighty-nine cases were settled with SEPs in 1993 under these same statutes, and, in that year, these accounted for forty percent of all SEPs within the agency.[415] Of these, twenty-eight percent were source reduction projects and sixteen percent waste minimization.[416] These numbers do not give a comprehensive picture because they look only at three specific regulatory statutes and programs under them. However, they do show generally that SEPs are being used as an active, viable regulatory policy option. In the spring of 1995 EPA reported that a total of forty pollution prevention SEPs had been finalized during fiscal year 1993 with a total compliance cost of approximately $30 million.[417] Most EPA non-criminal enforcement ac-

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or environment at large, and environmental justice. *See id.*

413. In 1993, EPA reported average penalty reduction to cost ratios of 6:1 for TOSCA, 6:1 for EPCRA and 4:1 for FIFRA for all SEPs under these programs for fiscal years 1991/1992. *See* EPA, INNOVATIONS IN COMPLIANCE AND ENFORCEMENT: SUPPLEMENTAL ENVIRONMENTAL PROJECTS IN EPA'S TOXICS AND PESTICIDES PROGRAM (March 1993) [hereinafter 1993 REPORT]. The following year, EPA reported an overall average ratio of 4:1 for SEPs under these statutes. *See* EPA, INNOVATIONS IN COMPLIANCE AND ENFORCEMENT COVERING FISCAL YEAR 1993 [hereinafter 1994 REPORT]. Both of these reports considered all SEPs, not just those that required pollution prevention or pollution reduction. *See* Mary Becker & Nicholas A. Ashford, *Exploiting Opportunities for Pollution Prevention in EPA Enforcement Agreements*, 29 ENV'T SCI. & TECH. 220, 223 tbl.2 (1995) [hereinafter Becker & Ashford, *Exploiting Opportunities*] (reporting a variety of penalty reduction percentages in the ten projects of that case study).

414. *See* 1993 REPORT, *supra* note 413, at 5.

415. *See* 1994 REPORT, *supra* note 413, at 3.

416. *See id.* at 5.

417. *See* EPA, EPA POLLUTION PREVENTION ACCOMPLISHMENTS: 1994, at 31 (EPA 1000-R-95-001, Spring 1995). The 40 pollution prevention SEPs were from a total of 293 SEPs. 1994 data were still being compiled. *See id.*

tions are concluded by a settlement, so there is great potential for pollution prevention SEPs.[418]

One study evaluated the pollution prevention impact of using SEPs in ten selected cases.[419] The report noted a number of successes, but also a few problems.[420] Negotiating a SEP is more complex, more difficult, and more time consuming than negotiating a traditional settlement, and the agency should make allowance for this in its internal evaluations of employees.[421] In addition, special technical support may be needed to assist case officers and attorneys negotiating the SEP. In general, case officers and attorneys who have experience with SEPs tend to use them much more than others. Presumably, more widespread training, technical support, and internal rewards for agency personnel would increase their use.

Firms also face a number of barriers to more effective use of SEPs, including the absence of top-level management support, limited technical expertise, short time periods required for negotiation and implementation of the projects, and fear of technical failure.[422] Most firms claimed to have previously considered the project that eventually became the SEP, and claimed that it would likely have been done eventually anyway, although it is difficult to evaluate these claims independently.[423] Companies tended to use both in-house expertise and outside consultants

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418. *See* Becker & Ashford, *Exploiting Opportunities*, *supra* note 413, at 220.

419. *See* RECENT EXPERIENCE IN ENCOURAGING THE USE OF POLLUTION PREVENTION IN ENFORCEMENT SETTLEMENTS: REPORT SUMMARY, PREPARED FOR EPA OFFICE OF ENFORCEMENT BY THE MIT CENTER FOR TECHNOLOGY, POLICY AND INDUSTRIAL DEVELOPMENT UNDER COOPERATIVE AGREEMENT (CR 819086, Feb. 1994) [hereinafter MIT REPORT SUMMARY]. Only the summary has been made publicly available. The report is discussed in Becker & Ashford, *Exploiting Opportunities*, *supra* note 413.

420. *See* MIT REPORT SUMMARY, *supra* note 419, § VI; *see also* EPA, IDENTIFICATION OF POLLUTION PREVENTION (P2) TECHNOLOGIES FOR POSSIBLE INCLUSION IN ENFORCEMENT AGREEMENTS USING SUPPLEMENTAL ENVIRONMENTAL PROJECTS (SEPS) AND INJUNCTIVE RELIEF (EPA-300-R-97-001, Mar. 1997).

421. *See* MIT REPORT SUMMARY, *supra* note 419, at 2-7.

422. *See id.* at 7-9.

423. *See* Becker & Ashford, *Exploiting Opportunities*, *supra* note 413, at 225.

for prevention projects.[424] Most of the projects undertaken tended to involve diffusion of existing technology rather than major innovation, although one project developed a major innovation: chlorine-free pulp bleaching.[425]

State use of SEPs has received little systematic study.[426] Several states fund part of their environmental protection programs through penalties and this prompts speculation that they may be less interested in penalty reduction programs.[427] However, some states have embraced multimedia enforcement, one has embraced multimedia permitting, and a number of others are studying these ideas.[428] These efforts can naturally lead to individual SEPs, and state policies on them would then likely follow.

SEPs can be a valuable tool to promote pollution prevention, but the tool has inherent limits. Because they are part of formal law enforcement, SEPs necessarily require that the prevention project and its implementation schedule be precisely specified. However, this precision limits the types of prevention projects that will be possible under an agreement. Thus, SEPs are particularly well suited to supporting diffusion of existing technology, particularly technology that has already been adapted for use in this industry. A great deal of environmental protection, and industrial development, can be attained through diffusion and SEPs could be instrumental in promoting it.

For the same reason, however, SEPs are unlikely to spark true innovation frequently. While radical innovations offer the greatest individual opportunities for technological change, they are risky, uncertain, and often delayed in coming to full fruition. Flexibility in the requirements and timing of performance would be of great help in promoting prevention through SEPs,[429] but

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424. *See id.* at 223.

425. *See id.* at 225.

426. None of the surveys of state pollution prevention efforts have separately discussed SEP policy. *See* EPA, BUILDING STATE AND LOCAL PROGRAMS, *supra* note 301; EPA, ENCOURAGING STATE INNOVATION, *supra* note 303; EPA, STATE POLLUTION PREVENTION INITIATIVES, *supra* note 303; WRITAR, STATE LEGISLATION, *supra* note 325.

427. *See Growth Expected in Program to Cut Fines in Exchange for Pollution Prevention*, 1993 ENV'T REP. 2692, 2694.

428. *See id.*

429. *See* MIT REPORT SUMMARY, *supra* note 419, § VI. The need for flexibility is discussed in EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 81-82, and in EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra*

the nature of the enforcement process will limit the flexibility that will be afforded.

Companies like SEPs because the net result is spending money to improve the company's environmental performance, rather than just to pay a fine.[430] Investments mandated by SEPs are usually either deductible business expenses or depreciable investments, although EPA's policy values the SEP by looking at its after-tax cost. By supporting environmental improvement, SEPs enhance internal and external corporate image. In this way, SEPs can use the enforcement process to support the growth of a company's pollution prevention program and help to internalize environmental protection in the corporate culture.[431] In addition, SEPs often support technology transfer, either within the plant, the company or the industry.[432]

Compliance and enforcement can also support prevention by providing structural incentives for agency personnel to consider and promote it. One of the best ways is with pollution prevention training for agency staff. Enforcement officials are steeped in the end-of-the-pipe pollution control mindset of the current regulatory system, rather than the inside of the facility where prevention takes place. Training and technical backup support is essential to change these perspectives.[433] EPA plans training sessions on its new SEP policy in each of the regions.[434] In addition, training for regulatory enforcement personnel is a consistent feature of the pollution prevention grants made by EPA to the states.[435] These are most encouraging signs.

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note 93, at 54-56.

430. *See, e.g., Growth Expected in Program to Cut Fines in Exchange for Pollution Prevention, supra* note 427, at 2693.

431. *See* Becker & Ashford, *Exploiting Opportunities, supra* note 413, at 224. The SEP process had a major role in changing the thinking of the President of one of the companies studied. "He now believes it is economically sensible to stay ahead of environmental regulations by eliminating hazardous operations." *Id.*

432. *See id.* at 223-24 (reporting that while this was true for most of the ten cases studied, it was too early to accurately determine how much transfer would result).

433. *See* EPA, PERMITTING AND COMPLIANCE POLICY, *supra* note 275, at 85-90; EPA, IMPROVING TECHNOLOGY DIFFUSION, *supra* note 93, at 85-87; EPA, BUILDING STATE AND LOCAL PROGRAMS, *supra* note 301, at 22-23.

434. *See* 1995 SEP Policy, *supra* note 405.

435. *See* EPA, ENCOURAGING STATE INNOVATION, *supra* note 303 (re-

The fourth of the recent policies are alternative regulatory mechanisms making compliance and enforcement more friendly to new technology. In essence, a business or facility agrees to achieve and maintain superior environmental performance, in exchange for less onerous reporting, inspection and compliance burdens, as well as public recognition.

All the programs are now in the early development and pilot project stages. Two of these regulatory efforts, Project XL and the Common Sense Initiative, also encompass alternative permitting plans and were discussed above, although they present some issues that are distinctly compliance related.

The Environmental Leadership Program, an EPA-sponsored project that predates the other two, is focused exclusively on compliance issues.[436] It is a pilot program under which a group of approved facilities will achieve and assure compliance through pollution prevention projects and enhanced environmental auditing.[437] In November of 1994 it was reported that forty facilities had applied;[438] ten private and two federal facilities were selected for the pilot project phase in April, 1995, and agreements were finalized with them in August, 1995.[439] They authorize and require more auditing and self-monitoring by the participants, with full disclosure to the relevant regulators.[440] In exchange, partici-

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viewing specific grant supported programs in Maine, Massachusetts, New York, Ohio, and Alaska, as well as briefly discussing programs in other states); EPA, STATE POLLUTION PREVENTION INITIATIVES, *supra* note 303.

436. *See* Environmental Leadership Program, 58 Fed. Reg. 4802 (Jan. 15, 1993).

437. *See Inspections at Plants to be Suspended In Environmental Leadership Pilot Program,* ENV'T REP., Apr. 14, 1995, at 2448. The initial notice of intent to establish the program is found in Environmental Leadership Program, *supra* note 436, at 4802; the request for proposals is found at, 59 Fed. Reg. 32,062 (June 21, 1994). *See also* EPA, POLLUTION PREVENTION 1997, *supra* note 304, at 36.

438. *Facilities Send EPA 40 Proposals For Leadership Program Pilot Projects,* ENV'T REP., Nov. 11, 1994, at 1346.

439. *Innovative Initiatives to Provide Facilities Relief Readied for Launch in 1997, Program Chief Says,* ENV'T REP., Oct. 18, 1996, at 1347.

440. In discussing participation in the Environmental Leadership Project, one industry participant referred to disclosure of the company's internal environmental audits as "probably an entry ticket." *Inspections At Plants to be Suspended In Environmental Leadership Pilot Pro-*

pants will be relieved of routine state and federal inspections and will receive greater government acceptance of self-certified performance.[441] They will also have a limited grace period to correct violations that do surface, provided those are not criminal and do not present imminent and substantial endangerment.[442] Final program requirements will be specified based on lessons learned in the pilot phase.[443] The aim of the program is to offer companies the option of negotiating alternative ways of meeting existing standards and establishing that they are in compliance.

Both Project XL and the Common Sense Initiative aim to go further. They envision alternative compliance regulation as part of a whole negotiated alternative regulatory system.[444] Rather than just focusing on compliance with existing standards, both programs aim to negotiate substitute alternative environmental management systems that will achieve enhanced environmental performance, but not necessarily keyed only to existing standards. This approach can be extended to negotiated agreements with whole industries, as well as with individual businesses or facilities, for improved environmental performance. Both proposals will consider the industries in the Common Sense Initiative as candidates for the programs.

The Common Sense Initiative establishes six industry-specific working groups made up of representatives from industry, regulatory agencies, environmental, labor, community and other stakeholder groups.[445] They are charged with proposing improvements to environmental regulation in a number of areas, including compliance and enforcement, and specific working committees are now being formed and forty projects have been initiated.[446]

Project XL was originally proposed in the spring of 1995 as part of the White House' program for reinventing environmental

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gram, *supra* note 437, at 2448.

441. *See id.* For example, companies participating in the Environmental Leadership pilot program will not be subject to routine inspections. *See id.*

442. *See id.*

443. *See id.*

444. *See Clinton's EPA Reform Plan Would Exempt Some Companies, Towns from Requirements*, ENV'T REP., Mar. 24, 1995, at 2231.

445. *See id.*

446. *See id.*

regulation.[447] It is establishing pilot projects to negotiate alternative environmental management strategies for improved environmental performance at individual facilities and industries.[448]

For all three programs, participation is based on application and individual approval by regulators, considering the applicant's compliance history, company programs, specific proposed projects, and other factors. As a practical matter, the programs offer participating companies much more flexibility in meeting and implementing environmental performance goals. In the short run, they unquestionably offer an opportunity to save compliance costs; in the longer run, they offer a much greater opportunity to mold the corporate culture and embed environmental protection values into the company's overall business and innovation strategies. Finally, they should offer public image benefits that flow from being certified and established as an "environmental leader".

The history of failed or abandoned pilot projects and other one-shot efforts casts a long shadow over these programs, however. These will be quite resource intensive efforts for the regulatory agencies because they demand individual negotiations and individual agreements with each facility. Further, these projects will attract particular scrutiny from both a skeptical environmental community and an uncertain but interested business community. Ultimately, they must become institutionalized within a bureaucracy that has, over time, proven itself successfully resistant to similar initiatives.

Taken together, these compliance and enforcement policies, programs, initiatives and policy ideas can support environmental technological change. Most are still in the formative or pilot project stage and final judgments must be reserved for further experience. However, more activity and movement is evident in this part of traditional environmental regulation than in either standard setting or permitting.

CONCLUSION

Pollution prevention, using better environmental technology, is crucial for the future of environmental protection. For the last twenty-five years we have been trying to protect the environment

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447. *See* Clinton & Gore, *supra* note 212.

448. *See* EPA, PROJECT XL, *supra* note 356, at 36-37.

by controlling pollution and this effort has had considerable success. However, more environmental protection is needed, and getting it through pollution control is proving harder and harder. The regulatory system keeps adding more and more rules, and increasingly specific controls, yet its progress in protecting the environment seems to be slowing down. To continue to move toward the needed level of environmental protection, we must add pollution prevention to our present pollution control efforts.

In addition, prevention offers the possibility of achieving environmental protection at less cost and in ways that may be supportive of other economic objectives. Preventing the pollution in the first place is often cheaper than treating it after the fact, and this will surely become even more true as the required level of treatment inevitably increases over time. Further, prevention is typically built on technological innovations that can also support other business productivity and competitiveness goals.

Pollution prevention, requires that business learn to produce economic goods and services without creating as many harmful wastes. For example, can water-based citrus cleansers be used in place of the chlorinated solvents that have been widespread for so long? Can an industrial process be redesigned to reclaim solvents and re-use its treated wastewater, rather than discharging it? Can products be redesigned so that less cleaning is needed, or less wastewater created, to make them? In most situations, better environmental performance turns on using environmentally better technology. Some technology is still to be developed; in other cases, there is simply a need for wider diffusion of existing technology. In either situation, the key is to require or inspire business corporations to develop and use the technology that is best for the environment. This Article is concerned with whether, and how, the traditional environmental regulatory system discourages and encourages business in this effort.

The traditional environmental regulatory system is of such great concern because, for better or worse, it is the prime motivator of business environmental performance. Regulation determines the minimum environmental performance requirements for business. But beyond this, it effectively defines the market for existing and new environmental technology. If a given technology is not approved for companies to meet their environmental requirements, that technology will disappear from the market, if it is even developed in the first place. A technology friendly environmental policy, so essential for pollution prevention, begins with a hospitable and supportive approach from the traditional regulatory system.

However, that system has not shown much concern for its impact on technology. The traditional system — writing regulations, issuing permits to individual sources, and seeking compliance and enforcement — has emphasized controlling pollution at the end-of-the-pipe or smokestack and has given little thought to preventing pollution by using new environmental technology inside the plant. This regulatory system inadvertently creates many incentives related to new technology: some supportive, many discouraging. The process of setting standards is so slow that it cannot itself prescribe the latest technology, and it has not generally done so. However, business reaction to the standards that do get set is varied. Both emissions standards and product standards have sometimes encouraged innovation and diffusion of cleaner technology, although each has often discouraged it. The process of issuing permits, as well as the compliance and enforcement process, show a deep-seated bias in favor of known, established pollution control technologies, although some exceptions can be found and there are some encouraging recent developments that show the beginnings of a change in regulatory thinking.

What accounts for the diverse technological responses to traditional regulation? As discussed in Part II, there are many variables, firm and industry-specific factors abound, and no one theory has captured the entire picture. This diversity should be expected, for technology innovation and diffusion are a phenomenon of a particular business time and place, as well as particular technological, financial and creative opportunity. However, some useful theories do offer quite substantial insight and predictive power and a technology-friendly policy must use them.

Technology-friendly regulation must consider a number of aspects of each particular business and industry situation. The most important single factor is the degree of youthful fluidity or mature rigidity in the firm or industry's underlying technology. After this, other important factors include the technological opportunities available, the nature of the firm's processes, the individual firm's culture and values, and the prospects for innovation from outsiders. The key point is that the extent to which a business is likely to develop or embrace new technology in response to regulatory stimuli is a reasonably knowable and predictable process. Regulators can craft environmental policies that will be consciously supportive of environmental technology, although they have not frequently done so.

A technology-friendly environmental policy can be crafted at two levels. There is much that can be done within the framework of existing environmental laws. When specific regulatory standards are set, they can expressly consider who is likely to create and apply new technology and what is likely to motivate those parties' behavior. The permitting process need not manifest its present bias in favor of familiar existing pollution control technology; neither must compliance and enforcement. However, all of these efforts require substantial technical and organizational support for agency personnel as they wrestle with the necessarily more complex questions presented by new technology, particularly new technology inside the plant rather than at the end-of-the-pipe. Further, new technology often takes longer to develop and perfect than installation of known options, and it presents a greater risk of failure; the regulatory system needs to make allowance for this to be truly effective.

Throughout Parts III, IV and V, a number of specific changes within the traditional system are discussed, as are an encouraging array of new and old agency experiments. These give a basis for some optimism, but it must be guarded optimism. These sections also chronicle a long history of pilot projects, one-shot experiments that have never been institutionalized and become part of business as usual within environmental regulatory agencies. The prevailing regulatory strategy continues to be pollution control, with only a thin veneer of pollution prevention rhetoric layered on top. The regulatory agencies continue to manifest a compliance-deterrence regulatory culture that can never fully support new technology. In addition to a change in specific regulatory policies, environmental regulation must eventually undergo a cultural change if we are to maximize a technology friendly environmental policy.[449]

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449. Interestingly, if ironically, this needed culture change is quite

Along with such a change in regulatory culture, a truly robust environmental technology policy would make more fundamental changes in the regulatory structure. A multimedia approach is key. This strategy requires multimedia statutes, supporting multimedia regulations, and regulatory agencies structured around specific industry sectors rather than individual environmental media as is now the case. Agencies organized by industry sectors will develop the knowledge of industry operations and technology possibilities. Companies genuinely and deeply committed to environmental technological advancement can be offered the option of alternative regulatory requirements and enforcement, keyed to alternative environmental management systems, in exchange to truly superior environmental performance.

Getting to this second level will be difficult and other priorities and policy concerns will have to be considered and accounted for. At best, it must be seen as a long-term objective, but certainly a worthwhile one. Such an environmental regulatory regime would provide much better long-term environmental protection, and it would support long-term goals of economic development and productivity.

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similar to the change to an innovation culture that business organizations must make if they are to effectively pursue pollution prevention policies. *See* Strasser, *supra* note 2, at 4-20.