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Economic Instruments for Sustainable Development

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A. Introduction

This chapter primarily addresses the means of environmental protection, as distinguished from its goals. Most writing about the question of means posits a dichotomy between 'command and control' regulation and economic incentive programmes, such as emissions trading and eco-taxes. This dichotomy, however, may distort our understanding of both traditional regulation and alternatives to it.

Because economic theory shows that 'economic incentive' programmes are more cost effective than traditional regulation, one might assume that economic incentive programmes offer a superior method for achieving sustainable development. This chapter questions that assumption. It argues that achieving sustainable development requires an emphasis on transformative technological innovation and that traditional economic incentive programmes do not work as well in this regard as commonly assumed.

This topic has taken on great importance as the use of economic instruments has spread worldwide. Their growing popularity has sometimes had little to do with the technical merits of competing approaches. Rather, governments skeptical of the efficacy of government intervention, such as the Thatcher government in Britain and the Reagan and George W Bush administrations in the United States (US), have tended to embrace a deregulatory philosophy that relies on the 'free market' to solve many social problems.[1] Those sharing this perspective have found 'market-based' approaches to environmental protection attractive.[2] These market-based

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[1] See generally H Stretton, *Public Goods, Public Enterprise, Public Choice: Theoretical Foundations of the Contemporary Attack on Government* (St Martin's Press, 1994); PM Jackson and CM Price, *Privatisation and Deregulation: A Review of the Issues* (Longman, 1994).

[2] See RB Stewart, 'Models for Environmental regulation: Central Planning versus Market-based Approaches' (1992) 19(3) *Boston College Envtl Affairs L Rev* 547; FE Anderson *et al, Environmental Improvement through Economic Incentives* (Johns Hopkins UP, 1977).

approaches have also proven congenial to many governments not as committed to free market ideology, such as those in Europe seeking a 'third way' alternative to the welfare state and laissez-faire.[3] They may view economic incentive approaches as moderating the excesses of command and control regulation, without giving in to a laissez-faire ideology.

The goal of this chapter, however, is not a thorough description of the political economy of instrument choice. Rather, it is to provide an introduction to the variety of instruments that have been labelled 'economic instruments' and to contribute to the assessment of their value to sustainable development. The chapter will begin with a review of traditional regulation, with some emphasis on correcting the misimpressions that the term 'command and control' creates. It will then review the nature of economic incentive programmes and the traditional theory behind them. The third part will explain the importance of technological innovation to sustainable development. The final part will question the traditional view that emissions trading programmes help much with technological transformation and suggest ways of encouraging a pattern of sustainable development through the design of instruments aimed at encouraging innovation.

B. Traditional Regulation[4]

The term command and control regulation suggests that regulators employing traditional regulation usually proceed by telling polluters how they must reduce pollution.[5] In fact, however, regulators very often set performance standards that limit the amount of pollution allowed, but do not dictate compliance techniques.[6] A good example of a performance standard comes from the New Source Performance Standard for coal-fired power plants that Professors Ackerman and Stewart addressed in their book, *Clean Coal/Dirty Air*,[7] a leading critique of 'command and control' regulation. While Professors Ackerman and Stewart claim that this standard required 'forced scrubbing', (ie, the use of coal scrubbers), the regulation itself required operators of power plants to meet a target for

[3] T Giddens, *The Third Way and its Critics* (Polity Press, 2000).

[4] See also Abbot, this vol.

[5] D Keeth, 'The California Climate Law: A State's Cutting-Edge Efforts to Achieve Clean Air' (2003) 30 *Ecology Law Quarterly* 715, 720 (characterising 'command and control' regulation as regulations where the government mandates particular technologies); DM Driesen, 'Is Emissions Trading an Economic Incentive Programme? Replacing the Command and Control Economic Incentive Dichotomy' (1998) 55 *Washington & Lee L Rev* 289, 290–1.

[6] Driesen, above n 5, 297–8.

[7] BA Ackerman and WT Hassler, *Clean Coal/Dirty Air: Or How the Clean Air Act Became a Multibillion-Dollar Bailout for High-Sulfur Coal Producers and What Should be Done About it* (Yale UP, 1981).

pounds of pollution per million BTUs or, in the alternative, a percentage reduction requirement.[8] The Court of Appeals that reviewed this regulation stated that 'given the current state of technology' this standard would require scrubbing.[9] But this statement implies that owners of coal-burning power plants could employ any new technology that came along, if it met the performance standard. Indeed, the regulation nowhere states that it requires scrubbing. Such performance standards have been common under the air and water pollution control laws of many countries and under the Convention on Long-Range Transboundary Air Pollution.[10]

Sometimes, however, setting a performance standard is not possible, because measurement of the pollution a facility releases is technically impracticable. In such a case, regulators often set 'work practice' standards that dictate the use of a technique known to reduce pollution, in lieu of requiring compliance with a performance standard.

An example is the regulation of asbestos emissions during building demolition.[11] Since destruction of buildings containing asbestos sends fibres hither and yon, one cannot measure the amount of asbestos emanating from a building undergoing demolition. Accordingly, when the US Environmental Protection Agency (EPA) regulated asbestos emissions in building demolitions, it did so by requiring a set of practices, such as wetting down the building, known to reduce emissions.[12] These command and control regulations are acts of desperation, denying regulated entities flexibility only because it is impossible to verify compliance with the more flexible regulatory instrument—the performance standard.

Whether the regulator establishes a performance standard or a work practice standard, the regulator must make decisions about how stringent the regulation will be—decisions about whether to require a great reduction in pollution or just a small reduction. Statutory criteria usually guide these administrative goal-setting decisions. Many statutes employ some kind of technology-based criteria. These imply that an administrative agency will establish the level of stringency that technologies are capable of achieving.[13] While writers often use the term 'command and control' regulation as a synonym for technology-based regulation, most technology-based regulation consists of performance standards, not technology-dictating work practice standards. Moreover, one can use technological capability to determine a regulation's goals and use emissions trading or pollution

[8] *Sierra Club v Costle,* 657 F 2d 298, 312 (DC Cir, 1981).
[9] *Ibid,* 316.
[10] Convention on Long-Range Transboundary Air Pollution 1979, 18 ILM 1442.
[11] C Twight, 'Regulation of Asbestos: The Microanalytics of Government Failure' (1990) 10 *Policy Studies Review* 9.
[12] *Adamo Wrecking Co v US,* 434 US 275, 277, 294–5 (1978).
[13] DM Driesen, 'Distributing the Costs of Environmental, Health and Safety Protection: The Feasibility Principle, Cost-Benefit Analysis, and Regulatory Reform' (2004) 32 *Boston College Environmental Affairs L Rev* 1.

taxes as the means of achieving those goals. In other words, technology-based emissions trading programmes and tax programmes are possible. So, one should not equate technology-based regulation with particular regulatory instruments. To avoid confusion, this chapter will use the term 'traditional regulation' to refer to both performance standards and work practice standards, rather than the term command and control regulation.

Traditional regulation, especially technology-based traditional regulation, has produced significant reductions in pollution in many countries. The US, for example, has developed technology-based federal standards for point sources of water pollution, which has, by most accounts, led to great reductions in pollution.[14] Although most analysts treat traditional regulations as the opposite of an economic incentive programme, a traditional regulation creates a significant economic incentive to reduce pollution.[15] Governments usually levy substantial fines on violators of traditional regulatory limits. Polluters conform to the limits, in part, to avoid these fines. Despite traditional regulation's success in reducing pollution, scholars have criticised traditional regulation on numerous grounds.

First of all, traditional regulation frequently makes inefficient use of private sector compliance expenditures.[16] Because facilities have uneven control costs, uniform standards for an industry category require relatively large compliance expenditures from some facilities, while requiring relatively small expenditures from others.[17] In theory, it is possible to get the same industry-wide reduction that a uniform standard demands at lower cost by demanding more reductions from facilities with low control costs and fewer reductions from facilities with higher control costs. The difficulty of acquiring good marginal control cost information for individual facilities, however, can limit a regulator's ability to engage in efficient fine-tuning of this nature.

While this cost effectiveness critique has merit, a seemingly related critique, claiming that traditional regulation is often excessively stringent, has also sometimes been cited in the US as a reason to prefer economic instruments. This argument usually rests on the proposition that command and control regulation often requires cost grossly disproportionate to benefit.[18] Recent work by Professors Heinzerling and Parker raises serious issues about the data underlying this critique.[19] The more

[14] WL Andreen, 'Water Quality Today—Has the Clean Water Act Been a Success?' (2004) 55 *Alabama L Rev* 537.

[15] JT Preston, 'Technology Innovation and Environmental Progress' in MR Chertow and DC Esty (eds), *Thinking Ecologically: The Next Generation of Environmental Policy* (Yale UP, 1997) 136, 148.

[16] RB Stewart 'Economic, Environment, and the Limits of Legal Control' (1985) 9 *Harvard Environmental L Rev* 1, 7.

[17] RW Hahn and RN Stavins, 'Incentive-Based Environmental Regulation: A New Era for an Old Idea?' (1991) 18 *Ecology Law Quarterly* 1, 3.

[18] See NO Keohane RL Revesz and RN Stavins, 'The Choice of Regulatory Instruments in Environmental Policy' (1998) 22(2) *Harvard Environmental L Rev* 313.

[19] RW Parker, 'Grading the Government' (2003) 70 *University of Chicago L Rev* 1345; L Heinzerling 'Regulatory Costs of Mythic Proportions' (1998) 107 *Yale LJ* 1981.

important point, for purposes of understanding the instrument choice debate, is that this argument may have little to do with instrument choice. The argument that a problem of excessively stringent regulation provides evidence of the need to use economic instruments seems to confuse means and ends. If a traditional regulation is desirable as a means of environmental protection, then a conclusion that environmental regulation is too strict could be met by relaxing the standards, not necessarily by changing the means of environmental protection. Moreover, since economic instruments have the potential to reduce compliance cost, cost effectiveness arguments favour them whether or not current regulations are excessively stringent. This stringency claim is more properly directed to a debate about the proper criterion for determining the goals of environmental regulation, and has less relevance to a debate about the means. And most proponents of this view lavish most of their energy on calls for more use of cost-benefit analysis to determine the goals of environmental regulations.[20]

Conversely, some environmentalists criticise trading programmes as efforts to subvert the achievement of environmental goals.[21] While this can be a fair criticism of the design of particular trading programmes, it should not be taken as a criticism of the concept of emissions trading itself.

Traditional regulation has been criticised for its failure to simulate innovation.[22] In fact, a dearth of post-compliance studies makes it difficult to know precisely how effective traditional regulation has been in stimulating innovation. There are a number of cases, however, where traditional regulation has stimulated significant innovation.[23] For example, some companies responded to the US Occupational Safety and Health Administration's regulation of vinyl chloride by employing a proprietary 'stripping process' or by employing other innovations.[24] These measures not only lowered vinyl chloride exposure but also improved vinyl chloride resin production. Manufacturers responded to regulation of occupational exposure to cotton dust through modernisation of equipment needed anyway

[20] Eg CR Sunstein, *The Cost-Benefit State: The Future of Regulatory Protection* (American Bar Association, 2002); CR Sunstein, *Risk and Reason: Safety, Law, and the Environment* (Cambridge UP, 2002); RW Hahn, *Reviving Regulatory Reform: A Global Perspective* (AEI-Brookings Joint Center for Regulatory Studies, 2000).

[21] OECD, *Implementing Domestic Tradeable Permits: Recent Developments and Future Challenges* (OECD, 2002).

[22] MH Levin and BS Elman, 'The Case for Environmental Incentives' (1990) 7(Jan/Feb) *Environmental Forum* 7, 8–9.

[23] K Strasser, 'Cleaner Technology, Pollution Prevention, and Environmental Regulation' (1997) 9 *Fordham Environmental LJ* 1, 32 (innovation sometimes results from emission and discharge limits); eg US Congress Office of Technology Assessment, *Gauging Control Technology and Regulatory Impacts in Occupational Safety and Health—An Appraisal of OSHA's Analytical Approach* (US Government Printing Office, 1995) 64; NA Ashford and GR Heaton Jr, 'Regulation and Technological Innovation in the Chemical Industry' (1983) 46 *Law & Contemporary Problems* 109, 139–40; NA Ashford, C Ayers and RF Stone, 'Using Regulation to Change the Market for Innovation' (1985) 9 *Harvard Environmental L Rev* 419, 440–1.

[24] US Congress, above n 23, 89; also Ashford *et al,* above n 23, 419–66.

to compete internationally.[25] Most metal foundries responded to regulation limiting workplace formaldehyde, not through the ventilation and enclosure approach expected by the regulator, but through development of low-formaldehyde resins.[26] While most established smelters responded to sulphur dioxide limits with a conventional approach, copper mining firms developed a new and cleaner process to assist their entry into the smelting business.[27] And operators of chloralkali plants responded to EPA regulation of mercury with some process innovations.[28]

Innovation tends to occur when regulators demand significant reductions through performance standards, thereby creating incentives for polluters to innovate to escape potentially high control costs. A good example involves decisions to phase out ozone depleting substances. While the Montreal Protocol[29] authorised some trading of compliance obligations, in practice most countries relied on a strict traditional regulatory approach, a phase out of ozone depleting substances, to achieve the Protocol's goals. Even when countries authorised trading, little or no trading occurred. The Montreal Protocol set off a wave of innovations as companies sought substitutes for the substances being phased out.[30]

Polluters have an economic incentive to use the flexibility performance standards offer, if they can meet the standard through innovations that provide less costly, but adequate, compliance methods. Nevertheless, some writers have suggested that technology-based performance standards discourage technological innovation, even when they allow it as a matter of law. Professor Stewart, for example, has argued that technology-based standards may provide an incentive to choose the technologies that regulators evaluated in setting a performance standard, in order easily to persuade the regulator of compliance.[31] Yet, this incentive may be less powerful than the incentive to innovate to escape high compliance costs. Polluters should have little difficulty in persuading regulators of their compliance when they can readily monitor pollution to show that their alternative technology does produce emissions meeting the performance standard. Similarly, when they choose to eliminate a pollutant from their production process to avoid costly regulation, they will have no difficulty at all persuading the government of compliance.

Thirdly, writers have criticised traditional regulation for slow plodding progress. They have associated traditional regulation with litigiousness and intensive lobbying.[32] This criticism accurately describes a central problem with

[25] US Congress, above n 23, 90.
[26] *Ibid,* 95.
[27] Strasser, above n 23, 28–29.
[28] Ashford, *et al,* above n 23, 437.
[29] Protocol on Substances That Deplete the Ozone Layer 1987, 26 ILM 1550.
[30] ER DeSombre, 'The Experience of the Montreal Protocol: Particularly Remarkable, and Remarkably Particular (2000) 19 *UCLA Journal of Environmental Law & Policy* 49.
[31] RB Stewart, 'Regulation, Innovation, and Administrative Law: A Conceptual Framework' (1981) 69 *California L Rev* 1256, 1269.
[32] See Stewart, above n 31; Ackerman and Hassler, above n 7.

traditional regulation in the US. But it raises questions about whether this problem stems from the selection of regulatory means, or from the culture of 'adversarial legalism' that prevails in the US.[33] Also, it is far from obvious that a move to economic instruments necessarily leads to a significant reduction in lobbying and litigation. President Clinton's effort to introduce a domestic carbon dioxide (CO_2) tax, the sort of economic incentive measure economists favour, stimulated a firestorm of lobbying that defeated the measure.[34] And polluters have lobbied and litigated to seek to weaken the design of emissions trading programmes, not just traditional regulation.[35] It is possible that the selection of less costly and more flexible instruments might offer some potential to reduce opposition to regulation. But we need more empirical and theoretical work on this question.

C. Types of Economic Instruments with Examples

Scholars usually use the term 'economic incentive programmes' or the synonym, 'market-based instruments', to refer to a wide variety of alternatives to traditional regulation.[36] This usage reflects convention, rather than a clear analysis of the differences between traditional regulation and the alternatives. For traditional regulatory programmes provide an economic incentive to clean up; they threaten polluters with fines for failing to comply with standards, as noted previously. Traditional regulation also creates a market for pollution control ideas and equipment, since it requires polluters to clean up. Regulations can raise the price of goods associated with large amounts of pollution, and therefore encourage consumers to substitute less polluting goods or reduce consumption, thereby further reducing emissions.

Even though all forms of regulation provide economic incentives to reduce pollution, scholars generally agree about what instruments the term 'economic

[33] N Gunningham and P Grabosky, *Smart Regulation: Designing Environmental Policy* (Clarendon Press, 1998) 6.

[34] See M Kriz, 'A Green Tax?' (1993) 25 (June) *National Journal* 917.

[35] Eg, *Appalachian Power Co v EPA,* 249 F 3d 1032, 1036–40 (DC Cir, 2001) (recounting the litigious history of a trading programme for regional nitrogen oxide emission reductions); *Texas Municipal Power Agency v EPA,* 89 F 3d 858, 861 (DC Cir, 1996) (litigating claim for additional emission allowances); *Indianapolis Power and Light Co v EPA,* 58 F 3d 643, 647 (DC Cir, 1995) (same); *Madison Gas and Electric Co v EPA* 25 F 3d 5246 (7th Cir, 1994) (same); *Monongahela Power Co v Reilly,* 980 F 2d 272, 272–4 (4th Cir, 1992) (same).

[36] Eg T Panayotou, *Instruments of Change: Motivating and Financing Sustainable Development* (Earthscan, 1998); J Rietbergen-McCraken and H Abaza, *Economic Instruments for Environmental Management: A Worldwide Compendium of Case Studies* (Earthscan, 2000); C Jeanrenaud, 'Economic Instruments for Environmental Policy' in C Jeanrenaud (ed), *Environmental Policy Between Regulation and the Market* (Springer Verlag, 1997) 3; OECD, *Economic Instruments for Pollution Control and Natural Resources Management in OECD Countries: A Survey* (OECD, 1999).

incentive programmes refers to, even if the term has no rigorous definition. And they use the term to refer to alternatives to traditional regulation. Scholars have also employed varying typologies to classify the many economic instruments used around the world. It might prove useful to distinguish between price-based instruments, quantity-based instruments and informational-based instruments.[37]

1. Price-based Instruments

Price-based instruments fall into three basic categories, those offering negative incentives, positive incentives or mixed incentives.[38] Negative incentives basically tax environmental destruction, thereby encouraging better environmental practice as a means of lessening the tax. Positive incentives enable those improving their environmental practices to earn money for doing so. Mixed incentives combine negative and positive incentives.

A pollution tax provides the quintessential example of a negative price instrument. Such taxes can induce pollution clean-up, if the cost of clean-up is less than the marginal tax rate. On the other hand, if the tax rate is less than the marginal cost of clean up, one can expect the polluter to pay the pollution tax, rather than to clean up. France's taxes on effluent, where the government charges a fee for each unit of water pollution discharged, exemplify pollution taxes.[39] Korea taxes sulphur emissions, whilst Sweden, Norway, Denmark and the Czech Republic tax the sulphur content of fuel, which correlates rather directly with sulphur emissions.[40]

The literature sometimes uses the broader term 'eco-taxes' to refer to a wide variety of negative price incentives, including not just direct pollution taxes, but also less direct taxes that aim to provide incentives for environmental protection. For example, Singapore charges high taxes on automobiles, fees for entry into the city and charges for driving during rush hour to discourage both congestion and the associated air pollution from cars.[41] None of these taxes constitutes a pollution tax, because they do not vary directly with the amount of pollution. But all of them encourage pollution reductions, because they discourage driving, which produces emissions. Almost all OECD countries levy some sort of tax on the purchase or use of vehicles,

[37] KR Richards, 'The Instrument Choice Game: When do Environmental Taxes Win?' in J Milne, K Deketelaere, L Kreiser and H Ashiabor (eds), *Critical Issues in Environmental Taxation: International and Comparative Perspectives* (Richmond Law and Tax, 2003) 66 (distinguishing between price-based and quantity-based emission limits).

[38] The general rationale for using price-based mechanisms in environmental policy is outlined in OECD, *Taxation and the Environment* (OECD, 1993); OECD, *Improving the Environment through Reducing Subsidies* (OECD, 1998).

[39] RN Stavins (ed), *Economics of the Environment: Selective Readings* (Norton, 2000) 437–38.

[40] OECD, *Environmentally Related Taxes in OECD Countries: Issues and Strategies* (OECD, 2001) 66–67.

[41] LH Lye, 'Environmental Taxation in the Regulation of Traffic and the Control of Vehicular Pollution in Singapore' in Milne *et al,* above n 37, 387–405.

although none is as environmentally effective as Singapore's. European countries, especially the United Kingdom, Norway and the Netherlands, impose rather high gasoline taxes, which may induce motorists to forego trips or use mass transit.[42]

Direct pollution taxes have been used sparingly around the world. Pollution taxes appear to enjoy more support in Europe than in the US, which seems to have an aversion to taxation generally. Most developed countries tax pollution indirectly through energy taxes, such as the gasoline tax, which produces the lion's share of revenue from pollution-related taxation in OECD countries.[43] These taxes tend to be much higher in Europe than in the US.[44]

While this chapter will give eco-taxes more extended treatment below, other negative price-based instruments exist. Commentators frequently mention liability as an economic instrument, because those potentially subject to liability for environmentally destructive activities may alter their conduct to avoid liability. The US Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[45] offers a frequently mentioned example. The CERCLA programme addresses the problem of abandoned toxic waste sites.[46] Because the party dumping waste often either has become insolvent or cannot be identified, this law makes a wide variety of parties having some association with a toxic waste site potentially liable for the clean-up costs.[47] While this programme has been criticised for sparking very time consuming litigation seeking to apportion the liability among those potentially responsible for disposal sites left behind by past dumpers, it has provided a powerful disincentive for others to dump waste.[48] Companies desperately want to avoid being caught up in CERCLA's liability net, so the liability provides a strong incentive to make sure that future wastes are eliminated or properly disposed of.

Liability can prove effective, but often provides too little certainty to motivate conduct change. For example, common law nuisance claims require proof that a

[42] See P Ekins, 'European Environmental Taxes and Charges: Recent Experience, Issues and Trends' (1999) 31 *Ecological Economics* 39.

[43] OECD, above n 40, 55. For a detailed review of many environmental taxes and a discussion of theoretical issues, see Milne *et al,* above n 37.

[44] *Ibid,* 57.

[45] 42 USC ss 9601–9675.

[46] JM Organ, 'Superfund and the Settlement Decision: Reflections on the Relationship Between Equity and Efficiency' (1994) 62 *George Washington L Rev* 1043, 1046.

[47] 42 USC s 9607(a).

[48] RL Steinzor and LE Greer, 'In Defense of the Superfund Liability Scheme: Matching the Diagnosis and the Cure' (1997) 27 *Environmental Law Reporter* 10286, 10290 (explaining that CERCLA provides incentives to avoid dumping hazardous waste); G Van Cleve, 'Would the Superfund Response Cost Allocation Procedures Considered by the 103d Congress Reduce Transaction Costs?' (1995) 25 *Environmental Law Reporter* 10134, 10134; JP Acton and LS Dixon, *Superfund and Transaction Costs: The Experiences of Insurers and Very Large Industrial Firms* (Rand Institute for Civil Justice, 1992); WN Hedeman, JZ Cannon and DM Friedland, 'Superfund Transaction Costs: A Critical Perspective on the Superfund Liability Scheme' (1991) 21 *Environmental Law Reporter* 10413, 10426 (criticising CERCLA's generation of transaction costs).

single polluter has interfered with the use or enjoyment of property. The difficulty of proving such a link in societies where multiple pollution sources combine to create health and environmental problems has often rendered nuisance law ineffective.[49] Indeed, the ineffectiveness of the common law liability regime led to the promulgation of modern environmental statutes.

In the wake of the US withdrawal from the Kyoto Protocol, New York's attorney general has spearheaded a suit to force reductions of CO_2 emissions from large power plants under a common law nuisance theory.[50] It remains to be seen whether the common law regime can prove an effective substitute for missing administrative action in this context.

Subsidies provide the most obvious example of a positive price incentive. Subsidies are moneys granted by government to reduce the private costs of specified goods, services or behaviour. They take many forms including grants, favourable loan terms, tax concessions and assumption of liability. They can provide incentives for environmentally beneficial behaviour, compensating those persons who perform environmental services of benefit to society.[51] Many governments, for example, subsidise clean renewable energy to some degree.[52] But subsidies often go to the companies that can lobby most effectively, which are often 'dirty' existing industries, rather than to companies employing the most environmentally beneficial approaches. In the US, for example, subsidies for environmentally dubious clean coal technology exceed the subsidies for renewable energy, and Germany has been criticised for subsidising coal.[53] If one counts tax exemptions, the US provides greater subsidies for older dirty energy than for newer cleaner energy. Subsidies can also encourage over-production. Both Europe and the US provide significant subsidies for agriculture, which may encourage greater use of pesticides and over-use of water, thereby contributing to associated water quality and supply problems.[54] On the other hand, governments tailor some

[49] On the limitations of common law torts as means of environmental protection, see J Lowry and R Edmunds (eds), *Environmental Protection and the Common Law* (Hart Publishing, 2000). A good example is the British case of *Cambridge Water Co v Eastern Counties Leather plc* [1994] 1 All ER 53.

[50] Press Release, Office of New York State Attorney General Eliot Spitzer, 'States, Cities, Environmental Groups Sue Bush Administration on Global Warming, Challenge EPA's Refusal to Reduce Greenhouse Gas Pollution' (23 Oct 2003).

[51] See F Cairncross, 'Natural Resource Management and Subsidies' in F Cairncross (ed), *Green Inc. A Guide to Business and the Environment* (Earthscan, 1995) 74; R Gale, S Barg and A Gillies (eds), *Green Budget Reform: An International Casebook of Leading Practices* (Earthscan, 1995).

[52] Eg BJ Richardson and KL Chanwai, 'The UK's Climate Change Levy: Is It Working?' (2003) 15(1) *Journal of Environmental Law* 39 (discussing UK government grants for clean energy and energy efficiency investments, financed from climate change levy revenues).

[53] N Myers and J Kent, *Perverse Subsidies* (International Institute for Sustainable Development, 1998).

[54] M Cardwell, 'Common Agricultural Policy Quotas and the Environment' (1997) 45 *Drake L Rev* 71; OECD, *Water Subsidies and the Environment* (OECD, 1997).

agricultural subsidies, such as soil conservation incentives, toward environmentally desirable ends.[55]

Some economic instruments combine positive and negative incentives. Deposit-refund systems are a frequently mentioned example. Many governments obligate sellers of beverages to collect a deposit from consumers associated with the cost of collecting bottles. This deposit funds a refund paid to a person when she returns the empty bottle for recycling.[56] It is doubtful that the negative incentive created by the deposit reduces waste, since the added cost is probably too small to affect beverage consumption.[57] But even small refunds provide a surprisingly powerful incentive to reduce litter, encouraging the unemployed, for example, to search for discarded bottles which they can redeem as a source of income. Denmark has created one of the most effective deposit-refund programmes in the world, in part, because it combines this economic instrument with a command and control regulation banning the use of aluminium beverage cans.[58] Another example of mixed negative and positive price incentives is the United Kingdom's landfill charge, which reduces the volume of waste and helps funds environmental restoration of former dump sites.[59]

2. Tradeable Environmental Rights

Tradeable environmental rights, or environmental benefits trading, offer the best example of a quantity-based economic incentive measure, as opposed to a price-based measure.[60] Quantity-based measures differ from price-based incentives in a fundamental way. With price-based instruments, government sets the price creating incentives to reduce. This government action leaves the private sector free to decide what quantity of pollution reduction to offer in response. By contrast, when government enacts a quantity-based instrument, such as an environmental benefit trading programme, the government, not the private sector, determines the requisite quantity of emission reductions. The private sector retains some control over the price through its ability to choose techniques to meet the quantitative limit.

[55] In the US, positive environmental subsidies have been introduced to encourage sustainable agriculture though the Conservation Reserve Programme, implemented under the Food Security Act 1985, Pub L No 99–198, 99 Stat 1504.

[56] F Ackerman, *Why Do We Recycle? Markets, Values, and Public Policy* (Island Press, 1997) 126.

[57] Generally *ibid,* 131–3.

[58] *Ibid,* 137–8.

[59] BJ Richardson, "Economic Instruments in EU Environmental Law Reform: Is the UK Government 'Sending the Right Signals'" (2002) 3 *European Journal of Law Reform* 427, 437.

[60] For an introduction to the vast literature, see eg TH Tietenberg, *Emissions Trading: An Exercise in Reforming Pollution Policy* (Resources for the Future, 1985); CL Kling, 'Environmental Benefits from Marketable Discharge Permits or an Ecological vs Economical Perspective on Marketable Permits' (1997) 11(1) *Ecological Economics* 57.

A performance standard, like a trading programme, constitutes a quantity-based instrument. But trading programmes differ from traditional performance standards in that governments authorise polluters (for example) to forego compliance with the government limit, if they purchase credits from some other polluter that has made 'extra' reductions, ie, reductions beyond those otherwise required. Thus, these programmes create markets in the trade of pollution reduction credits.

The same trading concept, however, applies to programmes addressing environmental problems other than pollution. Governments have applied trading approaches to land use problems. New York City employed a trading approach to the preservation of landmark buildings long before any government had applied this approach to pollution.[61] When it restricted development that would involve destruction of landmark buildings, it sometimes offered developers a right to build elsewhere in the city. These transferable development rights programmes have spread and offer a way of ameliorating the hardship of tight restrictions on development in especially sensitive locations.[62] And the US federal government has encouraged its states to use 'wetlands mitigation' banking. Under this approach developers may destroy otherwise protected wetlands, if they purchase credits created by developers enhancing wetlands, which have been 'banked'.

Many governments around the world have used transferable quotas to regulate fishing.[63] They limit the total allowable catch, but allow fishers to catch more than their individual quota by purchasing quota from other fishers. A recent review found that 24 of the 37 transferable quota programmes experienced declines in the fish stocks after implementing the programme.[64] These setbacks reflected failures to set sufficiently conservative limits and enforcement failures.[65] While tradeable quota programmes make enforcement more complex than in non-tradable quota systems, verification of compliance with non-tradable quotas has also proven difficult.[66] One might argue that a ban on especially destructive technologies, such as driftnets, might better address fisheries problems, since the tradeable quota system does not effectively address the issue of by-catch (the incidental destruction of species not targeted by the programme), and governments can more easily monitor fishing equipment than catches.

[61] JJ Costonis, 'The Chicago Plan: Incentive Zoning and the Preservation of Urban Landmarks' (1972) 85 *Harvard L Rev* 574, 576.

[62] JC Juergensmeyer, JC Nicholas and BD Leebrick, 'Transferable Development Rights and Alternatives After *Suitum*' (1998) 30 *Urban Lawyer* 441.

[63] See generally A Rieser, 'Prescriptions for the Commons: Environmental Scholarship and the Fishing Quotas Debate' (1999) 23 *Harvard Environmental L Rev* 393, 410 (discussing their use in the US); R Arnason and H Gissurarson (eds), *Individual Transferrable Quotas in Theory and Practice* (U Iceland Press, 1999).

[64] OECD, *Tradeable Permits: Policy Evaluation, Design, and Reform* (OECD, 2004) 24; also OECD, *Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources* (OECD, 1997).

[65] *Ibid,* 24.

[66] See generally DS Ardia, 'Does The Emporer Have No Clothes? Enforcement of International Laws Protecting the Marine Environment' (1998) 19 *Michigan Journal of Environmental Law* 497.

Governments have also occasionally used trading to address water, solid waste disposal and agricultural issues. The Dutch have introduced a nutrient quota system to limit phosphates flowing into rivers as a result of animal production.[67] Since it is not possible to measure the pollution directly, the government assigned each type of animal an assumed phosphate contribution amount, based on estimates of manure excretion.[68] Quotas limit phosphate pollution by limiting the number of animals, and farmers may sell quotas, which they frequently do when they go out of business. Trades have not reached great volumes, but the limits on animals have modestly contributed to reductions of nutrient loadings.[69]

Australia has created a trading system for water use rights.[70] Such a system tends to improve the economic efficiency of water use, but should have negative effects on the environment. The reason for this is simple. When a user has a right to more water than she can use, the water may remain in the river, where it supports instream flow and associated ecological values, such as sustaining fisheries and avoiding excessive salinity (at least until the water is used further downstream). If water rights can be sold, however, surplus water will be reallocated to some economic use, rather than being allowed to support environmental ones. Australia's programme so far has produced too few trades to have a large environmental impact, but analysts expect negative impacts on salinity.[71] Therefore, this programme has created the need for additional regulations to head off the negative environmental impacts the trading programme should produce.[72]

In the pollution control field, there have been several applications of tradeable emission allowances in the US, which are discussed in greater detail later in this chapter.[73] The most substantial example is the acid rain abatement programmeme, introduced by the 1990 amendments to the federal Clean Air Act.[74] It caps sulphur dioxide emissions from the power sector and allows participating power suppliers to trade their pollution allowances in a national market.[75] California's Regional Clean Air Incentives Market (RECLAIM) was introduced in 1994 to reduce levels of nitrogen oxides and sulphur oxides in the Los Angeles airshed.[76]

[67] OECD, above n 64, 99.
[68] *Ibid,* 102.
[69] *Ibid,* 112–14.
[70] *Ibid,* 135–53; M Bond and D Farrier, 'Transferable Water Allocations—Property Right or Shimmering Mirage' (1996) 13 *Environmental & Planning LJ* 213.
[71] OECD, above n 64, 146.
[72] *Ibid.*
[73] Section D, below.
[74] Pub L No 101–549, 104 Stat 2399, Pub L No 104–316, 1001 Stat 3838. See generally CC Park, *Acid Rain: Rhetoric and Reality* (Methuen, 1987).
[75] R Rico, 'The U.S. Allowance Trading System for Sulphur Dioxide: An Update on Market Experience' (1995) 5 *Environmental & Resource Economics* 115.
[76] See V Foster and RW Hahn, 'Designing More Efficient Markets: Lessons from Los Angeles Smog Control' (1995) 38 *Journal of Law & Economics* 19.

A number of states have also implemented effluent trading regimes to reduce water pollution, such as Wisconsin's Fox River programme.[77]

European interest in marketable permits has focused on greenhouse gas emissions. Denmark was the first European country to legislate a limited trading system for CO_2 quotas among the country's largest electricity producers.[78] In April of 2001, Great Britain piloted a system of negotiable, transferable emission permits as an adjunct to the government's new climate change levy.[79] In 2005, most of the remaining members of the European Union submitted emission trading programmes to the European Commission pursuant to an EU Directive on trading.[80]

3. Informational Policy Instruments

Most scholarly treatments of economic incentive measures include information-based programmes, not just price and quantity instruments, as examples of 'economic incentive' programmes.[81] Right-to-know programmes in numerous OECD countries require polluters to report the amount of pollution emitted in various media. The data are published in pollutant release and transfer registers such as the US's Toxics Release Inventory. There is evidence that these programmes have induced some heavy polluters to reduce their emissions.[82] In any event, it is not obvious that these programmes rely upon economic incentives. If polluters choosing to clean up are responding to fears that consumers may cease to buy their products or investors may decline to purchase shares in reaction to unfavourable data about their pollution levels, then it would be accurate to say that information-based approaches create an economic incentive for clean-up. On the other hand, if the clean-up reflects a more generalised concern with reputation or a desire to behave ethically, then the incentive might be thought of as moral or reputational, rather than purely economic.

Voluntary environmental certification systems provide another example of an information-based programme. Sustainable forestry or fisheries management programmes and environmental management systems seek to encourage more

[77] Michigan Department of Environmental Quality 'Water Quality Trading Programme', available at: www.deq.state.mi.us/swq/trading/Statesum.htm.

[78] Act No 376 of 2 June 1999. See OECD, above n 21, 74, 79–81.

[79] UK Department of the Environment, Transport and the Regions, 'Business and Climate Change', available at: www.environment.detr.gov.uk/climateoffice/10.htm.

[80] Directive 2003/87/EC of the European Parliament and of the Council of 13 Oct 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC [2003] OJ L/275/32.

[81] See generally DA Kysar, 'Preferences for Processes: The Process/Product Distinction and the Regulation of Consumer Choice' (2004) 118 *Harvard L Rev* 525; DC Esty, 'Environmental Protection in the Information Age' (2004) 79 *NYU L Rev* 115.

[82] BC Karkainnen, 'Information as Environmental Regulation: TRI and Performance Benchmarking, Precursor to a New Paradigm?' (2001) 89 *Georgetown L Rev* 257.

sustainable conduct by companies through private certification processes, which both spread information to companies about how to improve environmental management and provide information about environmental performance (or at least management systems) to consumers and suppliers.[83] These programmes may provide economic incentives to clean up to the extent that firms fear that consumers and suppliers may reduce purchases if environmental performance proves unsatisfactory.

Sometimes simply the provision of information to companies can bring about environmental improvements. Environmental management systems can encourage private companies to seek out information about profitable pollution prevention opportunities.[84] Voluntary government programmes can also aid in encouraging at least those environmental improvements that have no net cost. For example, energy efficiency improvements often pay for themselves over time. Once companies have adequate information about the cost savings, they often make these improvements voluntarily. In the US, the federal Environmental Protection Agency's 'Green Lights' programme has encouraged more efficient use of energy in commercial spaces.[85] The effectiveness of these programmes often depends on the adequacy of budgetary support to hire staff to spread the information.

Another example of an information programme comes from eco-labelling. Several European countries have required extensive labelling to reveal the environmental attributes of competing products. The European Union has legislated the most comprehensive eco-label scheme in the world, covering both products and services, though participation in the scheme is voluntary.[86] Eco-labels provide incentives for companies to conduct themselves in ways that earn labels that will allow them to attract customers. Proposition 65, a ballot initiative passed in California, offers an example of a particularly powerful application of the information-based approach.[87] This law requires companies to warn consumers when their products contain carcinogens. Concerns about the effects of this labelling on their sales and/or reputation led many companies to reformulate products, rather than label them in an alarming manner. This led, for example, to settlement of a court suit enforcing the labelling requirement with an agreement to cease manufacturing

[83] Leading examples include the Forest Stewardship Council, the Marine Stewardship Council, the ISO 14001 environmental management system standard and the EU's voluntary Eco-Management and Audit Scheme. Eg EE Meidinger, 'The New Environmental Law: Forest Management Systems' (2003) 10 *Buffalo Environmental LJ* 211; EE Meidinger 'Private Environmental Regulation, Human Rights, and Community' (2000) 7 *Buffalo Environmental LJ* 123.

[84] See J Voorhees, 'Global Environmental Solutions: Management Systems and Synchronicity' (1999) 28 *Stetson L Rev* 1155.

[85] US Environmental Protection Agency, *EPA Green Lights Program* (Environmental Protection Agency, 1993).

[86] Council Regulation 1980/2000 of 17 July 2000 on a revised Community eco-label award scheme [2000] OJ L/237/1.

[87] C Rechtschaffen, 'The Warning Game: Evaluating Warnings Under Proposition 65' (1996) 23 *Ecology Law Quarterly* 303.

lead pipe, which contributes to lead in drinking water, a significant public health concern.[88]

In spite of the value of labelling approaches, they pose some tricky issues. Limits exist to how much information consumers can process.[89] A tension exists between giving comprehensive reliable information that would fully inform consumers' environmental choices and the simplicity required to make it realistic to expect consumers to pay attention to the information. Yet, in an era in which market-based approaches and scepticism of government tend to dominate, a model of environmental protection that relies, at least to some degree, upon consumer sovereignty as a means of environmental protection has great appeal.[90]

No typology perfectly captures all instruments. For example, Germany has required producers to take back the packaging that comes with their products or otherwise provide for its proper recycling.[91] One can call this a command and control regulation, because it mandates a particular form of conduct and imposes performance standards, in the form of requirements for what percentage of material must be recycled.[92] But one might treat it as an economic incentive measure, because it creates an incentive to reduce the amount of packaging used. It is not obvious that this novel measure fits into any of the types above. But the distinction between price, quantity and information instruments does provide a useful tool for classifying and thinking about many instruments, including some that defy ready classification.

While the German law has required some adjustment over time and proven controversial, it calls attention to the importance of careful analysis of how incentives operate. Often, enthusiasm for free markets, especially among ideological governments, has led to a failure to carefully analyse precisely how the incentives offered by both traditional regulation and economic instruments operate. Belief in economic instruments as a panacea sometimes can cut short careful detailed analysis. The German recycling law rests on recognition that an approach to waste treatment that places the responsibility for disposal on local governments (the predominant approach) provides no incentives for producers to reduce the generation of wasteful packaging that ends up creating a disposal problem. By putting the responsibility for recycling on the producer, the German approach does create some incentives to reduce unnecessary packaging material. Whether one considers this a command and control regulation or an economic incentive programme is less important than the recognition that careful analysis of how incentives operate aids the design of all sorts of instruments.

[88] C Rechtschaffen, 'The Lead Poisoning Challenge: An Approach for California and Other States' (1997) 21 *Harvard Enrvironmental L Rev* 387.

[89] PS Menell 'Structuring a Market-Oriented Eco-Information Approach' (1995) 54 *Maryland L Rev* 1435.

[90] See generally Kysar, above n 81.

[91] Ackerman, above n 56, 107.

[92] *Ibid.*

Another example of a mixed instrument comes from the British approach to climate change. This programme combines emissions trading, a quantitative instrument, with a positive price incentive, a subsidy.[93] Under this programme, British firms can receive public subsidies if they agree to greenhouse gas emission reductions. This approach raises questions about departing from the polluter pays principle. Traditional regulation, pollution taxes and trading generally conform to this principle, but pollution abatement subsidies, ie, positive price incentives, do not.

D. Analysis of the Merits of Economic Instruments

Economists frequently recommend pollution taxes and emissions trading as 'economic incentive' measures capable of reducing pollution more cost effectively than traditional regulation.[94] Environmental benefit trading (including emissions trading) has assumed enormous prominence, becoming a common approach to fisheries management throughout the world, central to international negotiations on climate change, and ubiquitous for all sorts of environmental problems in the US. Direct pollution taxes, while less widespread, serve as the primary focus of economic analysis and policy prescription. And the analytical framework for pollution taxes aids analysis of indirect taxes aimed at pollution, which are more widespread in Europe than trading programmes. Accordingly, this discussion of the theory of economic incentives will focus primarily upon pollution taxes and trading.

1. Pollution Taxes

Economists generally prefer pollution taxes above all competing instruments.[95] A pollution tax can reduce pollution more cost effectively than traditional regulation. In theory, polluters with marginal pollution control costs less than the tax rate will respond to a pollution tax by reducing pollution to avoid some of the tax.[96] Polluters with marginal pollution control cost exceeding the tax rate will prefer paying the tax to reducing pollution.[97] Hence, a pollution tax can induce cost effective pollution reduction by encouraging greater reductions from facilities with low marginal control costs and fewer reductions from facilities with high

[93] OECD, above n 21, 19.

[94] Eg R Stavins, 'Experience with Market-Based Environmental Policy Instruments' in K Maler and J Vincent (eds), *Handbook of Environmental Economics* (Elsevier, 2003) 355, 359.

[95] For analysis of taxes versus tradeable rights, see CW Howe, 'Taxes Versus Tradable Discharge Permits: A Review in the Light of the U.S. and European Experience' (1994) 4(2) *Environmental & Resource Economics* 151.

[96] OECD, above n 40, 22.

[97] *Ibid.*

marginal control costs than a traditional regulation stimulating the same quantity of net reductions would.[98]

In practice, though, many governments design eco-taxes in a cost ineffective manner.[99] Instead of applying a uniform tax rate to all polluters emitting the target pollutant, governments often apply varying rates to different polluters and exempt the highest polluting products and firms from taxes outright.[100] Governments can, however, realise cost effectiveness benefits by designing more uniform taxes.

When consumers pay eco-taxes, they may respond by decreasing their purchases of goods with prices augmented by the amount of the tax.[101] They may either decrease consumption or choose to substitute less polluting goods.[102] Unfortunately, a lack of data and a dearth of ex post studies have left us without good estimates of the influence of existing taxes on pollution in many cases.[103] Available estimates, however, suggest that pollution taxes can prove effective. A Swedish ex post study found that taxes related to CO_2 emissions produced a 19 per cent drop in emissions between 1987 and 1994.[104] A Norwegian study found that carbon-related taxes reduced stationary source combustion emissions by 21 per cent from 1991 to 1995, but reduced household vehicle emissions by only 2 to 3 per cent.[105] Much of the industrial reduction in CO_2 emissions involved switching fuels, ie, substituting natural gas for coal.[106] Swedish taxes on nitrogen oxide and sulphur emissions have likewise contributed to significant declines in these emissions.[107]

Proponents of pollution taxes argue that they offer a 'double dividend'. Since many countries employ an income tax, a shift in the tax burden from income to pollution involves taxing 'bads'—ie, pollution—instead of 'goods'—ie, jobs. This gives rise to the double dividend hypothesis, the claim that pollution taxes will encourage job growth (or some other economic benefit) as well as a better environment.[108] This claim has proven controversial among economists. Whether or not the double dividend hypothesis proves correct, an increase in pollution taxes does provide an opportunity either to reduce other taxes or to increase government services. Indeed, pollution taxes can fund environmental improvement (as in the French effluent fee example).

[98] *Ibid.*
[99] OECD, above n 40, 126.
[100] *Ibid.*
[101] *Ibid,* 99.
[102] *Ibid,* 23.
[103] *Ibid.*
[104] *Ibid,* 109.
[105] *Ibid.*
[106] *Ibid.*
[107] *Ibid,* 106–7.
[108] This argument has been advanced most prominently in the debate regarding 'ecological tax reforms', reforms which aim comprehensively to overhaul the taxation and fiscal system rather than just focus on ad hoc environmental taxes: see further T O'Riordan (ed), *Ecotaxation* (Earthscan, 1997); T Barker, 'Taxing Pollution Instead of Employment' (1993) 6(1) *Energy & Environment* 1.

Indirect taxes can provide imperfect incentives for pollution reduction. Taxes on gasoline usage may do little to encourage changes in emission rates through reformulation of gasoline or installation of pollution control devices on cars. But they may encourage consumers to use cars less, thereby reducing emissions. Also, if energy taxes focus on polluting fuels only, they can create incentives to switch to less polluting fuels. The European Union's recent proposal to replace vehicle taxes with carbon related taxes may reflect some recognition of the limits of indirect eco-taxation.

Even direct pollution taxes can fail to perform properly if exemptions create perverse incentives. Denmark, France, Italy, the Netherlands, Norway, New Zealand and Sweden have introduced levies touted as carbon taxes.[109] These taxes apply to fossil fuels but vary with CO_2 content to some extent.[110] The lack of consistent correlation with CO_2 content stems from various exemptions and rebates serving non-environmental objectives, such as fair distribution of income and competitiveness.[111] Thus, for example, several of these carbon taxes exempt energy used in the generation of distribution of electricity, aviation fuel, and energy used in commercial fishing.[112] Exemptions can undermine either direct or indirect taxation's incentives greatly to reduce pollution.[113]

Still pollution taxes raise some tricky issues. For one thing, they may prove regressive. For example, taxes on energy or on pollution highly correlated with energy use can adversely affect the poor, since the poor spend more of their money on energy than the rich.[114] On the other hand, some non-pollution taxes are also regressive. For these reasons, many proponents of pollution taxes favour pollution taxes over other taxes that disproportionately affect the poor, or propose some adjustment to compensate for the regressivity of pollution taxes. These concerns have led most of continental Europe to impose relatively light taxes on home heating oil and the US, the United Kingdom, Canada and New Zealand to impose no such tax at all.[115]

Also, pollution taxes' environmental goals conflict, to some degree, with fiscal goals.[116] Governments imposing taxes usually hope to maximise revenue collection and minimise tax avoidance. Yet, pollution taxes will have their maximum environmental effect if they stimulate widespread tax avoidance, through pollution reduction. Perhaps an escalation of tax rates over time could help address this problem.

[109] *Ibid,* 55; Richardson and Chanwai, above n 52; Anon, 'New Zealand Sets Carbon Tax Rate', 2 *Carbon Finance,* May 2005, 12.
[110] OECD, above n 40, 56.
[111] *Ibid,* 55.
[112] *Ibid.*
[113] Stavins, above n 94, 355, 363–72.
[114] See C Larrue, 'The Political (Un)feasibility of Environmental Economic Instruments' in B Dente (ed), *Environmental Policy in Search of New Instruments* (Kluwer, 1995) 37.
[115] OECD, above n 40, 57.
[116] OECD, *Environmental Taxes and Green Tax Reform* (OECD, 1997) 30.

2. Emissions Trading

Environmental benefit trading can also reduce pollution in a cost effective manner.[117] Historically, the most prominent trading programmes have involved air pollution, and these will be the focus of the following discussion. But the trading concept applies equally to trading of other environmental benefits, such as effluent reductions, land conservation and fishing quotas.

An emissions trading programme begins with a regulator developing a performance standard for a group of regulated facilities, just as in a traditional regulation. This means that emissions trading, like command and control regulation, requires difficult government decisions about the stringency of regulation. It does not involve a spontaneous magical market.[118] Thus, for example, California's RECLAIM programme, which allowed for trades of air pollution reductions, led to an emissions increase in its early years for the simple reason that California set the cap for emissions above then current levels.[119] Government officials may either sell or give out emission allowances. In either case, the decision about how many allowances to give out or sell involves the same sort of decision that governments make when they set a performance standard.

In a trading programme, however, polluters need not comply with the performance standard if they pay another polluter who has 'over-complied', ie, reduced pollution (or the fish catch, or other environmental metric) below the required level. This trading of obligations should improve the cost effectiveness of environmental protection.[120] Polluters with relatively low marginal control costs will tend to make extra emission reductions in order to sell some of the surplus to other polluters. Polluters with high marginal control costs will tend to avoid local pollution control in favour of purchasing credits from facility owners enjoying relatively law marginal control costs. The trading programme accomplishes the same sort of redistribution of control obligations that a pollution tax accomplishes, shifting reductions from facilities with high marginal control cost to facilities with lowest marginal compliance cost. This shift makes emissions trading more cost effective than a traditional uniform standard.

While most accounts of emissions trading attribute the idea to the Canadian economist JH Dales,[121] the US has been the foremost champion of the trading approach. Vigorous US advocacy of the trading approach's value led to its inclusion as the principal compliance mechanism in the Kyoto Protocol to the Framework Convention on Climate Change,[122] the principal international

[117] JH Dales, *Pollution, Property, and Prices* (U Toronto Press, 1968) 92–100.
[118] DM Driesen, 'Markets are Not Magic' (Nov/Dec 2003) 20 *Envtl Forum* 19.
[119] OECD, above n 64, 48.
[120] See RA Devlin and RQ Grafton, 'Marketable Emission Permits: Efficiency, Profitability and Substitutability' (1996) 29 *Canadian Journal of Economics* 260.
[121] Dales, above n 117,
[122] (1998) 37 ILM 22; (1992) 31 ILM 849.

agreement addressing global climate change. While emissions trading has enjoyed a somewhat chequered history in the US, it has become a dominant approach there and increasingly influential internationally.[123]

The US began experimenting with trading under the 1977 Amendments to the Clean Air Act.[124] The US Environmental Protection Agency (EPA) authorised states to substitute plant-wide standards for pollution source specific standards. Because many plants contained multiple pollution sources, this allowed trading limits among different sources within a plant. Because this sort of intra-facility trading treats a plant as if a bubble enclosed it, US air pollution experts often refer to these limited trading programmes as 'bubble' programmes.[125]

It is widely known that these bubbles saved polluters millions of dollars.[126] But these cost savings often came from emissions fraud of various kinds, where plants claimed to make fresh reductions when they had not made any or convinced regulators to accept past measures as a substitute for fresh further progress.[127] These programmes were an economic success, but an environmental failure in many cases.

An early experiment in more widespread trading, ie, trading between facilities and not just within them, involved water pollution discharges into Wisconsin's Fox River.[128] This experiment, however, produced only one trade.[129] While economists generally considered this a failure attributable to a thin market, the lack of trades involves a loss of cost savings. If the reductions planned for occurred, the programme succeeded environmentally. It just did not differ significantly from what a traditional regulation would achieve.

In 1990, however, Congress enacted a well-designed emissions trading programme to reduce sulphur dioxide, a pollutant causing 'acid rain', which produced

[123] Driesen, above n 5, 291–2 (giving some examples of how extensive reliance upon trading has become); Stavins, above n 94, 392 (noting the increasingly frequent use of tradeable permit systems in the US).

[124] W Griffin, 'The EPA's Emissions Trading Policy: A Clouded Past, But a Bright Future' (1992) 20 *Northern Kentucky L Rev* 207, 218–33.

[125] I use the term 'bubble' to refer to a variety of approaches that involve the bubble concept. This includes netting and offset programmes under the Clean Air Act. See TH Tietenberg, 'Economic Instruments for Environmental Regulation' (1995) 6 *Oxford Review of Economic Policy* 17 (defining the bubble more narrowly and explaining offsets and netting).

[126] WJ Baumol and WE Oates, *The Theory of Environmental Policy* (2nd edn, Cambridge UP, 1988) 171–2; RW Hahn and GL Hester, 'Where Did All the Markets Go? An Analysis of EPA's Emissions Trading Program' (1989) 6 *Yale Journal of Regulation* 109, 128; AB Jaffe and RN Stavins, 'Dynamic Incentives for Environmental Regulations: The Effects of Alternative Policy Instruments on Technology Diffusion' (1995) 29 *Journal of Environmental Economics & Management* S–43, S–43–44.

[127] California Air Resources Board and US EPA, *Phase Three Rule Effectiveness Study of the Aerospace Coating Industry* (EPA, 1990) 4 (finding that almost all aerospace facilities under a bubble are not complying with regulatory limits); D Doniger, 'The Dark Side of the Bubble' (July 1985) 4 *Environmental Forum* 33, 34–5; RA Liroff, *Reforming Air Pollution Regulation: The Toil and Trouble of EPA's Bubble* (Conservation Foundation, 1986) 62–67, 80–91 (providing examples of bubbles used to avoid pollution reduction requirements).

[128] Michigan Department of Environmental Quality, above n 77.

[129] OECD, above n 21, 29.

serious ecological harms.[130] This programme, unlike most bubble programmes, featured continuous emissions monitoring, a cap on the mass of emissions, and clear, game-proof rules. This enhanced design produced the first major success with emissions trading, a great decline in emissions and significant cost savings coming from redistribution of reductions, rather than emissions fraud.

Citing the acid rain programme's success, the US successfully urged the international community to make trading central to the Kyoto Protocol, notwithstanding the very different context provided by an international agreement on climate change.[131] Thus, the Kyoto Protocol anticipates international trading of credits, which creates fresh problems of international co-ordination not present in a merely national emissions trading programme.[132] While the principal greenhouse gas, CO_2, can be reliably monitored, other gases subject to the protocol present some of the same monitoring problems that infected the bubble programmes (which applied to difficult to monitor volatile organic compounds).[133] Also, the Protocol as elaborated in subsequent agreements contemplates some credits for programmes that do not reduce emissions, but rather improve the capacity of land to sequester CO_2. This raises a host of methodological and monitoring issues.

Notwithstanding President George W Bush's decision not to ratify the Kyoto Protocol, Europe has continued down the international emissions trading path suggested by the US. Meanwhile, the US copied attributes of the failed bubble programmes at least as often as it copied key features of the successful acid rain programme in creating new pollution control programmes. For example, the US has heavily promoted wetlands mitigation banking, which involves allowing otherwise illegal development on some land in exchange for wetland enhancement and restoration activities elsewhere.[134] These restoration and enhancement projects have rarely succeeded. So, this wetlands trading programme, like the bubble programme, has saved money without always delivering comparable value. Many states have continued to authorise trading of pollutants that cannot be properly monitored through 'open market' trading programmes that the federal EPA has encouraged.[135]

[130] Park, above n 74.

[131] DM Driesen, 'Free Lunch or Cheap Fix? The Emissions Trading Idea and the Climate Change Convention' (1998) 26 *Boston College Environmental Affairs L Rev* 1, 27.

[132] DM Driesen, 'Choosing Environmental Instruments in Transnational Legal Context' (2000) 27 *Ecology Law Quarterly* 1.

[133] OECD, above n 40, 119–20.

[134] See RC Gardner, 'Banking on Entrepreneurs: Wetlands, Mitigation, Banking and Takings' (1996) 81 *Iowa L Rev* 527 (for a very thorough review of this programme).

[135] These programmes do not cap the mass of emissions, but instead encourage generation of credits in anticipation of regulatory limits driving demand for them. See RE Ayres, 'Developing a Market in Emissions Credits Incrementally: An "Open Market" Paradigm for Market-Based Pollution Control' (1994) 25 *Environmental Reporter* 1522, 1525.

These programmes have also produced embarrassing failures, thus emulating the bubble programmes.[136]

Trading frequently poses equitable issues that limit its utility. For example, California's RECLAIM programme, an emissions trading programme, authorised facilities releasing toxic chemicals in low income communities of colour to forego reductions reducing high local cancer risks in exchange for reductions from similar pollutants from vehicles driven throughout the Los Angeles metropolitan area.[137] Even if these vehicle reductions were well monitored, the problem of foregoing reductions in a community of colour with relatively high exposure to cancer-causing pollution would pose an environmental justice issue. A closely related issue involves what Professors Salzman and Ruhl call the 'currency' of emissions trading.[138] Most trading regulations use a fairly simple unit to measure credits and debits, such as the amount of a pollutant emitted from a facility or the number of acres of wetlands restored. But these metrics do not guarantee that the public gets full value when a trade occurs. For example, a trade allowing destruction of 10 acres of wetlands in exchange for restoration of 10 acres elsewhere might allow the destruction of a parcel with enormous ecological or flood control value in exchange for a restoration of a wetland with relatively little environmental value.

The acid rain programme gained acceptance, because it seemed to pose few of these equitable and equivalence issues. Acid rain comes from atmospheric loadings of sulphur dioxide (and other pollutants) across a large region, so that the geography of reductions is not nearly as important as the total quantity reduced. Even so, Congress included a provision allowing a local deposition standard to be set, if the acid rain programme produced hot spots of acid rain.[139] Europe had used a similar 'critical loads' concept in implementing the Convention on Long Range Transboundary Air Pollution.[140] Thus, if the geography of reductions failed to ameliorate the acidification of a particular ecosystem, scientists would calculate how much deposition should decline to address the environmental problem and government officials would derive appropriate geographically specific emission reductions from that calculation. As it happens, the programme produced significant reductions from Midwestern power plants that have a large impact upon New York's Adirondack Park (a state protected reserve that has been a major focus

[136] Eg, US Environmental Protection Agency, 'Approval and Promulgation of Air Quality Implementation Plans; New Jersey; Open Market Emissions Trading Programme' (18 Oct 2002) 67 *Federal Register* 64347 (announcing EPA decision not to proceed with processing New Jersey SIP revisions, because New Jersey had found such serious problems in its emissions trading programme that it was planning to abandon it).

[137] RT Drury *et al,* 'Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy' (1999) 9 *Duke Environmental Law & Policy Forum* 231, 251–5.

[138] J Salzman and JB Ruhl, 'Currencies and the Commodification of Environmental Law' (2000) 53 *Stanford L Rev* 607.

[139] LB Parker *et al,* 'Clean Air Act Allowance Trading' (1991) 21 *Environmental L* 2021.

[140] (1979) 18 ILM 1442.

of potential concerns about hot spots), so a deposition standard proved unnecessary. Greenhouse gases also seem to pose few difficulties for emissions trading in terms of equity and equivalence issues, as it does not seem that the geography of reductions matters much, at least for purposes of addressing climate change itself (some collateral benefits of reducing greenhouse gases have local consequences).

In short, trading programmes have a good record in saving money. Their record in meeting environmental and equitable objectives has been decidedly mixed. It is not hard to see why. A well designed programme for pollutants that can be well monitored and pose only minor geographic issues can work well, but trading works badly when applied to pollutants that cannot be well monitored, when rules do not carefully preclude gaming, or when simple metrics do not produce environmentally reliable and equitable trades.

While a casual review of the literature might lead to the impression that emissions trading offers a viable alternative to command and control regulation, it cannot substitute for true command and control regulation dictating compliance techniques. Regulators resort to true command and control regulation precisely in the situation where trading cannot work well, when good monitoring is impracticable. In that situation, direct pollution taxes do not work properly either. The acid rain experience shows, however, that a well designed trading programme can sometimes offer a viable alternative to a performance standard.

E. Innovation and Sustainable Development

1. Instrument Choice for Innovation: Taxes, Trading and Traditional Regulation

While writers sometimes use the term 'sustainable development' as a synonym for environmental protection, most have in mind a substantial change in the pattern of development. While the sort of change envisaged has many elements, a vision of significant technological change lies at the heart of sustainable development. A brief analysis of the problem of climate change can show why this is so.

Currently, the industrial world employs a development pattern heavily dependent upon burning fossil fuel. This pattern of development has contributed to a warming of the Earth's average surface temperature. As population and consumption increase, fossil fuel consumption will tend to grow.[141] This implies rising CO_2 emissions, which will increase the warming. Scientists associate this warming with rising sea levels inundating coastal areas, more droughts in areas where hunger is

[141] DM Driesen, *The Economic Dynamics of Environmental Law* (MIT Press, 2003) 9.

already widespread and a spread of infectious diseases.[142] This suggests that current patterns of development premised on increased use of fossil fuels are not sustainable. If this is correct, then sustainable development requires development of technologies that can lessen unsustainable dependence on increased use of fossil fuels, which are not renewable resources. Choosing instruments for sustainable development therefore implies choosing instruments most likely to encourage progress toward a sustainable technological base.

The track record of emissions trading programmes and traditional regulation as instruments to stimulate innovation is both mixed and incomplete (because of a dearth of post-compliance studies of many regulations, especially in the US)[143]. Both types of programmes have often encouraged increased diffusion of conventional technologies, rather than significant advances in the development of technology. Some writers have claimed that the acid rain programme has encouraged technological innovation.[144] Most utilities complied with the acid rain trading programme by employing scrubbers or switching to low sulphur coal. While many writers have referred to these approaches as innovations, they constitute the best understood conventional approaches to reduction of sulphur dioxide emissions from utilities. While scrubbers usually are quite conventional, some scrubber designs deployed under the acid rain programme have received patents, so utilities may have produced some innovation under this programme.[145] The most thorough review of the history of technological change in sulphur dioxide control to date, however, 'does not support' the conclusion that trading provides superior innovation incentives.[146] Similarly, the economist David Popp concludes that fewer scrubber designs received patents under the acid rain programme than under the prior new source performance standards.[147] But, he claims, the acid rain produced more scrubber designs improving control efficiency under the acid rain programme.[148] This suggests that trading reduces the frequency of innovation,

[142] Intergovernmental Panel on Climate Change, *Climate Change, 2001: Issues, Impacts, Adaptation, and Vulnerability: Summary for Policy Makers* (Cambridge UP, 2001) ch 3.5, 4.7.

[143] DM Driesen, 'Does Emissions Trading Encourage Innovation?' (Jan 2003) 33 *Environmental Law Reporter* 10094, 10103–5 (reviewing the empirical literature); AB Jaffe *et al,* 'Environmental Policy and Technological Change' (2002) 22 *Environmental & Resource Economics* 41, 55.

[144] Eg B Swift, 'Command without Control: Why Cap-and-Trade Should Replace Rate Standards for Regional Pollutants' (Mar 2001) 31 *Environmental Law Reporter* 10330, 10331, 10338; B Swift, 'The Acid Rain Test' (May–June 1997) 14 *Environmental Forum* 17 (describing fuel switching and use of scrubbers as 'innovations' from the acid rain programme).

[145] D Popp, 'Pollution Control Innovations and the Clean Air Act of 1990' (2003) 22 *Journal of Policy Analysis & Management* 641. For a detailed discussion of the technologies employed in the acid rain programme, see DM Driesen, 'Does Emissions Trading Encourage Innovation?' (2003) 33 *Environmental Law Reporter* 10094, 10105; generally AD Ellerman *et al, Markets for Clean Air: The US Acid Rain Programme* (Cambridge UP, 2000).

[146] M Taylor, E Rubin and D Hounshell, 'Regulation as the Mother of Invention: The Case of SO_2 Control' (2005) 27 *Law & Policy* 348, 370.

[147] Popp, above n 145, 62.

[148] *Ibid.*

but may change the type of innovation. While one can find examples of stringent traditional regulation encouraging significant innovation, often traditional regulation also encourages conventional approaches, like scrubbers.

The literature recognises that the question whether emissions trading encourages significant innovation is more complicated theoretically than the question whether it is cost effective.[149] Many writers supporting the view that trading encourages innovation point to its ability to encourage polluters to go 'beyond compliance' in order to have credits to sell into the market. But as the economist David Malueg pointed out a number of years ago, this analysis focuses only on the incentives facing facilities with relatively low marginal control costs.[150] Facilities with relatively high marginal control cost increase emissions above otherwise required levels in trading programmes. Trading programmes create less impetus for owners of these high cost facilities to innovate than an identically designed performance standard (where trading is not allowed) would create. Hence, trading provides inferior innovation incentives for half the market and superior innovation incentives for the other half, relative to a comparably designed traditional regulation. The difficult question is whether the net incentives provided by a trading programme for all sources encourage more innovation than would occur in a comparably designed non-trading programme.

Economists have recently begun to recognise that a tension might exist between the traditional goal of efficiency and the goal of encouraging significant technological change.[151] Economists often employ the 'induced innovation' hypothesis—the hypothesis that high costs induce innovations to avoid them—in analyzing innovation in free markets.[152] But in the past they have usually ignored this hypothesis in analyzing emissions trading's effect upon innovation. Since emissions trading lowers the cost of routine compliance, the induced innovation hypothesis suggests that emissions trading lowers incentives for innovation relative to a traditional regulation with the same emission limits.

[149] Eg JF Bruneau, 'A Above n on Permits, Standards, and Technological Innovation' (2004) 48 *Journal of Environmental Economics & Management* 1192; JP Montero, 'Permits, Standards, and Technology Innovation' (2002) 44 *Journal of Environmental Economics & Management* 23; JP Montero, 'Market Structure and Environmental Innovation' (2002) 5 *Journal of Applied Economics* 293 (trading, taxes, or traditional regulation can best encourage research and development when firms' products are strategic substitutes); DA Malueg, 'Emissions Credit Trading and the Incentive to Adopt New Pollution Abatement Technology' (1987) 16 *Journal of Environmental Economics & Management* 52; WA Magat, 'Pollution Control and Technological Advance: A Dynamic Model of the Firm' (1978) 5 *Journal of Environmental Economics & Management* 95.

[150] Malueg, above n 149, 29; D Wallace, *Environmental Policy and Industrial Innovation: Strategies in Europe, the USA, and Japan* (Royal Institute of International Affairs, 1995) 20 (explaining that Malueg's more sophisticated model casts doubt on the claim that emissions trading spurs innovation).

[151] KE Rosendahl, 'Cost-Effective Environmental Policy: Implications of Induced Technological Change' (2004) 48(3) *Journal of Environmental Economics & Management* 1099 (questioning 'fully flexible implementation of the Kyoto Protocol' because of potential spillover effects from technological innovation).

[152] Eg RG Newell *et al,* 'The Induced Innovation Hypothesis and Energy-Saving Technological Change' (1999) 114 *Quarterly Journal of Economics* 941.

Emissions trading surely discourages relatively expensive innovation. Without trading, high cost facilities have an incentive to create innovations that cost less than their marginal cost of pollution control. Under trading, no need exists to seek out these relatively costly innovations. High cost facilities will purchase credits from low marginal cost facilities instead.

This may not greatly trouble those who value highly emission trading's capacity to lower the cost of achieving any given short-term goal. But high cost innovation may have special value for sustainable development. While some incremental changes may occur through low cost innovation, developing technologies powerful enough to supplant coal-fired power and gasoline-burning car engines may require substantial investment. This investment may prove extremely valuable in the long run, even if the short-term costs are high. Substituting a renewable technology for a fossil fuel-based approach can simultaneously reduce a whole raft of pollutants and thereby produce a panoply of environmental benefits. These potential benefits include reduced climate change impacts, less urban smog, less acidic aquatic ecosystems, fish with lower mercury levels, fewer oil spills and water free from pollution from oil, mining and drilling. Also, while significant innovations usually require significant outlays to deploy in their earlier years, as their use becomes more common, costs often drop. For this reason, an investment in today's expensive new technology may ultimately lead to cheaper ways of meeting human needs for energy.

Emission trading creates an incentive to choose the technology capable of meeting the trading programme's performance standard with the lowest short-term cost. There is no reason to assume that this choice will coincide with the cheapest long-term dollar cost or the greatest long term environmental benefit.

Pollution taxes have a greater potential to promote innovation than either emissions trading (at least when permits are given away, rather than sold) or traditional regulation. Both emissions trading and performance standards produce incentives only to attain the standards government sets, rather than to go further. While trading does provide incentives for low cost sources to produce some 'extra' credits, it does so only to the extent that high cost sources need credits to meet their limits. Once the high cost sources have purchased enough credits to attain their limits, no further incentive to go beyond compliance exists. Pollution taxes, however, provide a continuous incentive for polluters to deploy innovations costing less than the marginal tax rate. Nevertheless, a recent OECD report notes that in spite of a fairly long history of environmental taxation in OECD countries, we have 'scant information' on technological development in response to eco-taxes.[153]

Any instrument can provide good incentives to innovate if government makes tough decisions. If it sets high pollution tax rates or strict performance standards

[153] OECD, above n 40, 112.

for either traditional regulation or emissions trading, then routine compliance options can become unattractive and polluters will tend to innovate. In practice, however, government often faces significant pressures not to set tough standards.

Other design elements can influence innovation rates as well. For example, regulators have a choice between writing standards that limit the *rate* of emissions and writing standards that limit the *total mass* of emissions. Rate-based standards limit the emissions per unit of output. For example, utility regulations often limit the pounds of pollutant per kilowatt hour of electricity. Since these standards limit only emission rates, increased output under these standards can increase pollution. By contrast, regulators have sometimes written standards limiting the total mass of pollutants allowed from a unit. Under this sort of standard, regulated parties must reduce the emissions rate if they wish to increase output, because the standard limits the total mass of emissions allowed. Standards that limit the total mass of emissions, rather than just the rate of emissions per unit of output, provide better innovation incentives than rate-based standards. While most writers on economic incentives associate rate-based standards with command and control regulation and mass-based limits with emissions trading (largely because the frequently studied acid rain programme uses mass-based limits), in reality, regulators have sometimes written rate-based emissions trading programmes and mass-based traditional regulations. The question whether to use mass-based or rate-based limits constitutes a design question that writers of traditional or trading programmes should confront.

The pressures on government to limit the stringency of standards and other practical impediments can limit the use of mass-based limits in trading programmes, notwithstanding their effectiveness in stimulating innovation. For example, averaging programmes for vehicles have usually involved rate-based limits,[154] because limiting the mass of vehicle emissions would require limits upon driving. The Austrian Ecopoints programme indirectly limits the mass of emissions through driving restrictions, and its history illustrates the political difficulty of such an approach. Austria became concerned about rising emissions and noise caused by increased European truck traffic across it territory, especially in the Brenner valley. The European Commission addressed this problem through an 'Ecopoint' programme that limits the nitrogen oxides per kilowatt hour for large trucks.[155] The European Commission distributes allowances based on 1991 traffic shares.[156] Because the allowable Ecopoints decrease over time, this approach should favour both improved nitrous oxide reduction technology and limits on driving trucks. In order to make sure that this programme reduced noise as well as emissions, it provided for a decrease in total distributed Ecopoints

[154] OECD, above n 21, 16.
[155] *Ibid.*
[156] *Ibid.*

should the number of transit trips increase by more than 8 per cent over 1991 levels.[157] In 1999 when transit trips increased sufficiently to trigger the reduction in Ecopoints, a dispute erupted between Austria and other EU members which had to be resolved by the European Commission and the European Court of Justice.[158] While this programme indirectly limits mass, it does not provide tradeable allowances,[159] which illustrates that the form of limits is separable from the issue of whether a regulatory programme allows trading or not.

2. Innovation through other Policy Instruments

Because trading programmes, taxes and traditional regulation have limited ability to stimulate innovation, regulators around the world have sometimes relied upon other instruments to stimulate innovation. For example, several European countries and US states have used 'renewable portfolio' standards to encourage use of renewable energy.[160] These standards require utilities to rely upon renewable energy sources for a specified percentage of output or require large-scale purchasers of electricity to buy a specified percentage of renewable energy.[161] This sort of command and control regulation suggests a recognition that a simple requirement to use more progressive technology may produce innovation more reliably than to seek to stimulate technological change indirectly through performance standards, emissions trading or pollution taxes.

Recently, however, several countries and states have begun implementing tradeable renewable energy certificates.[162] Such systems combine government technological mandates, albeit a mandate to use a range of technologies rather than one favoured technology, with the flexibility of trading to reduce the compliance cost.

The international regime governing ozone depleting substances used perhaps the most effective innovation simulating approach, simply banning a traditional obnoxious technology, in this case, the use of ozone depleting substances.[163] This can stimulate innovation, since users of banned substances and their suppliers feel an economic imperative to come up with substitutes. Other examples include Great Britain's phase-down of coal and the US phase-out of certain pesticides.

[157] *Ibid,* 157.
[158] *Ibid,* 157–8.
[159] *Ibid,* 155 (describing this as a cap but not trade programme).
[160] KS Golden, 'Senate Bill 1078: The Renewable Portfolio Standard: California Asserts its Leadership' (2003) 30 *Ecology Law Quarterly* 693, 701, 704 (listing states within the US that have adopted renewable portfolio standards, California's legislature considered but rejected a credit trading system to allow trading of the obligation to incorporate a fixed percentage of renewable energy into production plans); RL Ottinger and R Williams, 'Renewable Energy Sources for Development' (2002) 32 *Environmental Law* 331, 349–50 (discussing countries with renewable portfolio standards).
[161] OECD, above n 21, 16 (in most cases, obligations for renewable energy are 'formulated as minimum shares of renewable energy sources in total electricity output').
[162] *Ibid,* 105–36.
[163] Montreal Protocol on Substances that Deplete the Ozone Layer (1989) 26 ILM 1550.

It is open to debate whether such standards are a distinct form of regulation. A ban or phase-out can be viewed simply as a stringent performance standard, requiring zero emissions of a particular substance. But unlike a zero-emission standard, a ban does not simply prohibit emissions, it prohibits the manufacture, sale or use of the substance altogether. A ban might alternatively be considered a work practice standard. While many work practice standards tell regulated entities what to do, a ban or phase-out tells regulated entities what *not* to do.[164] Thus, a ban on ozone depleting chemicals widely used as solvents and refrigerants does not command any particular approach to refrigeration or degreasing. It leaves the field wide open to innovation.

Liability rules, if sufficiently onerous, can also stimulate innovation.[165] After the US government failed to enact a phase-out of asbestos, tort liability bankrupted asbestos manufacturers and forced the development of substitutes. But onerous liability has come under attack in the US and has never commanded much support in other countries. Also, problems of proof limit its capacity to stimulate environmental innovation.

Information regimes can sometimes stimulate innovation. For example, right-to-know laws requiring US chemical companies to report toxic releases appear to have led to pollution prevention within the industry.[166] California's Proposition 65 requiring labelling of carcinogens led to citizen suits settled by supplanting lead pipe with technologies posing less risk to human health.[167]

Pollution taxes can stimulate innovation more effectively when the proceeds pay for innovation.[168] The idea of using negative economic incentives to fund positive economic incentives can provide the clue to designing better instruments for sustainable development. For example, New Zealand sold fishing permits and dedicated some of the proceedings to paying some fishermen to retire, thus reducing overall pressures to allow too much fish to be taken.[169] California and other state legislatures have considered a 'feebate' proposal.[170] This proposal would

[164] If work practice standards are defined to include product standards, bans and phase-outs can be considered a relatively common form of work practice standard. Product standards have been used to prohibit or require the phase-out of such products or components as brominated fire retardants, ozone depleting substances, pesticides, silicone breast implants and lead in gasoline.

[165] See S Shavell, 'Liability for Harm Versus Regulation of Safety' (1984) 13 *Journal of Legal Studies* 357; P Wetterstein (ed), *Harm to the Environment: The Right to Compensation and the Assessment of Damages* (Clarendon Press, 1997).

[166] Emergency Planning and Community Right-to-Know Act, 1986, 42 USC §§ 11001–11050.

[167] California Office of Environmental Health Hazard Assessment, 'Proposition 65', available at www.oehha.org/prop65/background/p65plain.html.

[168] MS Anderson, *Governance by Green Taxes: Making Pollution Prevention Pay* (Manchester UP, 1994).

[169] See RO Boyd and CM Dewees, 'Putting Theory into Practice: Individual Transferable Quotas in New Zealand's Fisheries' (1992) 5 *Society & Natural Resources* 5.

[170] D Ingram, 'Emissions Panel Looks at "Feebate" Proposals' (17 Dec 1994) *Winston-Salem Journal,* available at www.journalnow.com/servlet/Satellite?pagename=WSJ%2FMGArticle%2FWSJ_BasicArticle&c=MGArticle&cid=1031779730489.

impose a fee upon purchasers of high emission vehicles, the proceeds of which would provide a rebate to customers who purchased low emission vehicles. Such an approach could significantly influence the incentives facing manufacturers, encouraging them to compete to produce cleaner vehicles in order to sell to customers who have extra money in their pockets (through the rebate).

One could build on this model to emulate competitive free market dynamics using an 'environmental competition statute'. This statute would require high polluting firms in an industry to reimburse their competitors who pay for the environmental improvements that allow them to achieve lower pollution levels and pay them a preset premium on top of that. Such an approach could create a race to become the cleanest facility, a race fuelled by incentives similar to those existing in competitive markets. Firms that innovate and achieve superior levels of pollution control would stand to profit and firms that failed to achieve superior levels would pay. Competitive markets tend to encourage innovation because of fear and greed. Firms' greed encourages innovation in hopes of grabbing market share from competitors. Firms' fear of losing market share to more innovative competitors encourages innovation. The environmental competition statute creates similar incentives, with the transfer payment from high to low polluting firms functioning much like a shift in market share. Such an approach would require an anti-collusion rule, otherwise regulated firms might agree not to compete to limit emissions, thereby incapacitating an environmental competition statute. Absent such collusion, a properly designed environmental competition statute may stimulate a race to the top.

Government research and development offers a very different approach to innovation. While the current era tends to de-emphasise the value of government in leading innovation, government has often brought together leading scientists to meet major technical challenges such as the development of atomic power, the internet, and the fuel cell. So, it might provide a fruitful approach to solving technical challenges in the environmental area. On the other hand, government research can be misdirected if special interest influence predominates, as the example of US government programmes aimed at 'clean coal' illustrate. But little incentive exists to deploy environmentally beneficial technologies in private markets without government in some way creating a demand for the technologies' use. All instruments of environmental regulation, even much maligned command and control regulation, create some incentives to use environmental technology that free markets do not provide.

All of this points to the need for a more imaginative search for approaches capable of stimulating transformative innovation, such as the environmental competition statute described above. Secondly, it calls attention to the importance, not just of selection of instruments, but of design considerations, such as decisions about stringency, in stimulating innovation. Thirdly, it should lead to more judicious use of emissions trading, instead of a glib assumption that trading offers some kind of panacea for sustainable development. Fourthly, it reminds us

that traditional regulation, if designed to stimulate innovation, can prove effective in paving the way toward sustainable development.

F. Conclusion

Economic instruments have become an increasingly important environmental policy tool in many jurisdictions over the past 30 years. Pollution taxes, tradeable emission allowances and other economic instruments can enable society to achieve the same environmental goals of traditional regulation at a lower cost, or superior environmental outcomes at the same cost. In other words, they have the potential to increase the efficiency of environmental protection. But instrument choice for sustainable development requires a conscious decision to make transformative innovation a priority, rather than just assume that such innovation will emerge as a by-product of the use of the most cost effective instruments. That decision should lead to more imaginative use of economic incentives, careful attention to design issues for all instruments, targeted use of traditional regulatory approaches and perhaps government research (in some countries) to provide a technical basis for a technological transformation towards sustainability.