Penn State Environmental Law Review

Volume 12 | Number 1 Article 10

1-1-2004

Greenhouse Gas Mitigation Action Planning: An Overview

Adam Rose

Greenhouse Gas Mitigation Action Planning: An Overview

Adam Rose*

I. Introduction

Most states and large municipalities are engaged in some form of greenhouse gas mitigation planning, and the rest of them are facing increasing pressures to do so.[1] Each month brings new evidence of the likelihood and the severity of the impacts of climate change, as well as news of advances in technology and policy design to reduce mitigation costs.

This paper provides an overview of the major steps needed to design, implement, monitor, and evaluate a Greenhouse Gas Mitigation Action Plan (GHG MAP). It is intended as a primer on the subject at a strategic level that applies to states and large metropolitan areas, although much of it is also applicable to smaller areas. Even though this paper includes real world examples and insights from thirty years of personal experience on the general subject matter,[2] it does not provide

* Professor of Energy, Environmental, and Regional Economics, Department of Geography and Center for Integrated Regional Assessment, Pennsylvania State University; Professor and Head, Department of Energy, Environmental, and Mineral Economics, Penn State University, 1988-2002; Professor, Department of Mineral Resource Economics, West Virginia University, 1981-88; Assistant Professor, Department of Economics, University of California, Riverside, 1975-81; Senior Council Economist, New State Council of Economic Advisors, 1974-75. The author wishes to thank Don Brown for the many insights to formulating a GHG MAP during discussions over the past year, as well as for comments on an earlier draft. Brent Yarnal and Howard Greenberg offered several helpful suggestions on an earlier draft. The opinions offered in this paper, however, are solely those of the author.

1. CENTER FOR CLEAN AIR POLICY, STATE AND LOCAL CLIMATE CHANGE POLICY ACTIONS (2002).

2. While a Ph.D. student, the author was provided access to one of the first large air pollution emission inventories in the form of "Emission Files" for nearly 20,000 industrial processes, boilers, and incinerators in Upstate New York (all of the State except New York City and Long Island), compiled by the New York Department of Environmental Conservation in the early 1970s. The inventories contained data on pollution emissions, stack-gas characteristics, and pollution control equipment.

many technical details. For these, the reader is referred in the footnotes to guidebooks authored by the Environmental Protection Agency,[3] and other government and non-government organizations, as well as action plans authored by enlightened political jurisdictions[4] and other general professional literature.[5]

In this paper, the definition of mitigation is used in its broadest sense to include sequestration, which captures GHGs from the atmosphere or from economic processes in a manner that neutralizes their potential harm. In addition, several aspects of adaptation, or coping with consequences of climate change after the fact, are presented. The discussion is not limited to technological options, but also includes, behavioral changes and policy refinements. An overview of the 17 steps in the GHG MAP and their interactions is presented in Figure 1.

Unfortunately, pollution control cost data were sparse and those available were considered unreliable. The author applied cost-engineering formulas to the stack and equipment parameters to estimate direct mitigation costs (Adam Rose, *The Cost of Stack-Gas Cleaning in New York State*, 25 J. OF THE AIR POLLUTION CONTROL ASS'N at 1005-08 (1975)); developed a linear programming model to identify the least-cost strategy to meet emissions reduction targets for particulates (Adam Rose, *A Dynamic Interindustry Model for the Economic Analysis of Air Pollution Abatement: Theory and Applications*, 5 REGIONAL SCIENCE MONOGRAPH, CENTER FOR URBAN DEVELOPMENT AND RESEARCH, CORNELL UNIVERSITY (1976)); and developed an input-output model to analyze statewide economics impacts (Adam Rose, *A Simulation Model for the Economic Assessment of Alternative Air Pollution Regulations*, 17 J. OF REGIONAL SCIENCE at 327-44 (1977)). Subsequent research was undertaken on refining regional economic impact modeling (A. Rose, *Modeling the Macroeconomic Effect of Air Pollution Abatement*, 23 J. OF REGIONAL SCIENCE at 441-59 (1983)); analyzing state and national air quality management plans under the Clean Air Act and its subsequent amendments (Adam Rose and R. Wolcott, *The Economic Effects of the Clean Air Act*, PUBLIC-INTEREST ECONOMICS, WASHINGTON, DC (1982)); and analyzing greenhouse gas mitigation policy in various other studies cited below.

3. State and Local Climate Change Program, Office of Policy, Planning and Evaluation, Environmental Protection Agency, States Guidance Document: Policy Planning to Reduce Greenhouse Gas Emissions (2d ed. 1998).

4. New Jersey Department of Environmental Protection, New Jersey Sustainability Greenhouse Gas Action Plan (1999).

5. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001 (Cambridge Univ. Press) (2001). The reader is especially referred to summaries of State Action Plans contained in EPA, *supra* note 3, and CCAP, *supra* note 1.

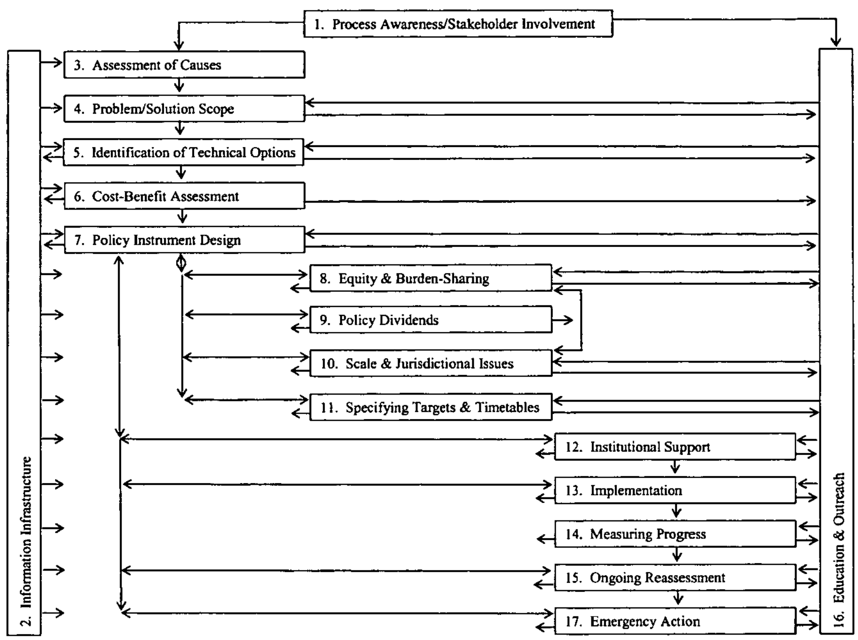

FIGURE 1. SCHEMATIC OF GHG MAP DEVELOPMENT

II.Stages Of GHG Mitigation Planning

1. Process Awareness

At the outset, it is important to realize that there are only a few shortcuts to create a successful GHG MAP. It requires the input of many people, large amounts of data, and substantial cooperation. It is unlikely that a successful Plan can be imposed solely from the top down, or that it will simply arise spontaneously from the bottom up. The Plan is best addressed as an interactive and iterative process that includes government officials, expert analysts, and those impacted by climate change or remedial policy, which includes everyone.

Public, or stakeholder, participation is not simply a vacuous buzzword, but an explicit goal in a democracy, as well as a pragmatic tool for information gathering, design, feedback, and implementation.[6] Practically everyone is a stakeholder, though not everyone will be able to participate directly. Appropriate representation is a key starting point, and must balance interest, vulnerability, responsibility, and manageability. In this regard, it should be remembered that government

6. THOMAS C. BEIERLE & JERRELL C. CAYFORD, DEMOCRACY IN PRACTICE: PUBLIC PARTICIPATION IN ENVIRONMENTAL DECISIONS (Resources for the Future Press) (2002); Robert E. O'Connor, Patti J. Anderson, Ann Fisher, & Richard J. Bord, *Stakeholder Involvement in Climate Assessment: Bridging the Gap between Scientific Research and the Public*, 14 CLIMATE RESEARCH, 255 (2000).

officials are representing the general citizenry and should have in mind the best interest of the entire jurisdiction, even though some, and perhaps, many individuals and groups, will feel excessively burdened. Although an open negotiation process is preferable to a closed one, it will be necessary to maintain some confidentiality to ensure that data and candid policy positions are readily forthcoming.

Climate change is a long-term problem that requires a long-term solution. In addition, important aspects of the problem are subject to change, including potential damage, mitigation costs, and scientific uncertainty, both for the present and for the future. GHG mitigation planning therefore is best viewed as an evolutionary process that will need to go through a number of phases. In order to get the process started in light of the uncertainties, voluntary action might dominate the first phase, but as GHGs continue to build up in the atmosphere and evidence of damage keeps mounting, more stringent emission caps will become necessary. This is likely to require strong leadership from elected officials, because self-interested emitters will not undertake the mitigation required to promote the best interests of society and to address spillover effects and free rider problems. Interestingly, this same situation applies to an entire political jurisdiction vis-à-vis the global community, again due to the transboundary nature of the problem and the fact that any jurisdiction can benefit from the actions of others without contributing directly to the solution. Regard for the national interest and for international treaties must be maintained.

2. Information Infrastructure

Developing a GHG MAP will require voluminous amounts of data, not just on the current situation, but on its history and future potential (e.g., future GHG emissions). It is critical to identify the best data and methods. Meaningful unit, such as sector, institution, household type, etc., should disaggregate the data. Therefore, development of protocols for specifying the data, standardizing definition and measurement, and archiving, is critical.[7] The GHG MAP will also require forecasts, which in turn, will require sophisticated models and expert analysts.

Many actively engaged in the process of developing a GHG MAP are aware of the "climate change problem" and its seriousness, but it is necessary to carefully document the GHG MAP for the broader range of participants. In addition, it is important to place the evaluation of the problem in the context of broader goals, such as a clean environment and

---

7. Brent Yarnal, *Human Environment Research Observatory Annual Report*, The Pennsylvania State University, University Park, PA (2002).

a sustainable economy, and to determine how the problem affects those goals. The development of quality of life indicators is a significant complement to the GHG Map effort.[8]

Key data should begin with indications of climate change, such as temperature, rainfall levels and variabilities, as well as the impact these climate changes have on major receptors such as health, economic activity, natural sources, and ecosystems.[9] It is critical not to ignore to assess the extent of uncertainty in the level and timing of these impacts. Finally, a voluminous amount of data is required on mitigation options and their costs, as well as data on background economic conditions.

3. Assessment of Problem Causes

While it is often taken for granted that climate change, especially the long-term increase in temperature, is caused by a build-up of greenhouse gases, and that most GHGs are generated by economic activities, careful documentation is still warranted. The most obvious place to begin documentation is with a GHG inventory. Although excellent guidelines for this step exist,[10] they have their shortcomings. For example, compilation of the Pennsylvania GHG Emissions Inventory[11] indicates data reporting for electric utilities on energy use was obscured by deregulation, and not just in that state. Still other errors are caused by shortcuts, such as basing vehicular emissions on gasoline use and ignoring driving-related factors.[12] Also, due to economic cycles and market peculiarities, data for any one year may be limited in its representation, so a time series would be most useful.

Simply compiling an inventory, however, does not get at the

8. Pennsylvania Consortium for Interdisciplinary Environmental Policy (PCIEP), *Pointing Pennsylvania Toward a Sustainable Future*, (2001). NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION, *supra* note 4. STATE AND LOCAL CLIMATE CHANGE PROGRAM, OFFICE OF POLICY, PLANNING AND EVALUATION, ENVIRONMENTAL PROTECTION AGENCY, *supra* note 3 distinguishes between "goals," which refers to broader societal aims, and "criteria," which are benchmarks to assess alternative policy options. The latter includes such considerations as efficiency, equity, and feasibility, many of which will be discussed below.

9. Ann Fisher, et al., *Preparing for a Changing Climate: The Potential Consequences of Climatic Variability and Change, Mid-Atlantic Overview* (2000) (*available at* http:// www.essc.psu.edu/mara).

10. ICF Consulting Group Inc., *Estimating Greenhouse Gas Emissions, in* EIIP Document Series—Volume VIII (1999) (Greenhouse Gas Committee, Emission Inventory Improvement Program).

11. Adam Rose, et al., *Greenhouse Gas Emissions Inventory for Pennsylvania* (Report to Pennsylvania Department of Environmental Protection, Center for Integrated Assessment) (2003).

12. R. Neff, Greenhouse Gases and the Commute to Work (2003) (unpublished Ph.D. Thesis, The Pennsylvania State University) (on file with author).

underlying causes of why certain types of fuel and economic behavior are most prominent in the generation of GHGs therefore basic "sources" or determinants should be identified by the use of various decomposition methodologies.[13] An analysis of the Pennsylvania GHG Inventory indicates upward pressure on emissions over the past decade was greatest from economic growth and an increase in the fossil energy intensity of the electric utility industry, primarily because of the decline in nuclear power in the State. These emissions were only partially offset by a decline in the dominance of the electric utility industry and in the energy intensity of manufacturing, both offsets caused by the demise of heavy industry in Pennsylvania. Some of these factors are controllable, while others are general secular trends beyond the scope of even the best GHG MAP.

4. Establishment of the Scope of the Problem and Its Solution

GHGs that warrant the major focus of the Plan must be identified in terms of considerations of prominence and controllability. Moreover, it is helpful to identify the target-related features of the problem, such as energy use. The major generators of GHGs must be identified both for the purpose of indicating responsibility for the problem and its resolution, including providing the major generators with a place at the negotiating table.

It is useful to specify a ballpark range of emission reductions and tradeoffs among GHGs and among emitters. This focuses the decision process by making it the support processes (data gathering, analysis, etc.) more manageable. These targets can also be compared to those of other jurisdictions to gauge the relative contribution to the solution of the problem.

5. Identification of Technical Options

The first area of this investigation is determining the technical feasibility of ways to reduce GHGs. In some cases this also pertains to political, legal, and behavioral feasibility. Analysts have identified a sequence of options, ranging from lowest to highest cost as follows:[14]

---

13. Stephen D. Casler and Adam Rose, *Carbon Dioxide Emissions in the U.S. Economy Environmenta: A Structural Decomposition Analysis*, 11 ENVTL AND RESOURCE ECON. 349-63 (1998); F.Q. Zhang and B.W. Ang, *Methodological Issues in Cross-Country/Region Decomposition of Energy and Environmental Indicators*, 3 ENERGY ECON. 179-90 (2001).

14. Stephen D. Casler and Adam Rose, *supra* note 13; F.Q. Zhang and B.W. Ang, *supra* note 13. The examples below pertain primarily to mitigation in industrial, commercial, and utility processes and are almost entirely of a structural (technological)

a. Conservation, including technological improvements and behavioral measures. These have even been found to more than pay for themselves.[15]

b. Fossil fuel substitution. Natural gas generates only slightly over half as much carbon dioxide as does coal per BTU. Some dual-fired boilers exist, but generally this requires substitution or some adjustment of technology.

c. Non-fossil fuel substitution. This entails replacement of activities fueled by coal-oil, or gas by renewables, such as wind, solar, and geothermal. It also, however, provides an entrée for nuclear power, though tradeoffs in potential environmental damage must be assessed.

d. Technology substitution. This entails replacement of an entire production process by one that emits fewer GHGs. The capital cost may be sizeable, but it is not unusual to find examples where the life-cycle costs represent a net savings.

e. End-of-pipe treatment. In this case, the predominant alternative is "industrial carbon management," which calls for removing carbon from combustion exhaust gases and sequestering it in depleted oil/gas wells or in the deep oceans.[16]

f. Geo-engineering. This refers to alternatives such as cloud ionization, which also might have unknown or potentially catastrophic side effects.

g. Biological sequestration. This refers to slowing down the cutting of trees and/or planting new forests.[17]

Another approach, and one that is more of an entire strategy than an option, is adaptation, which refers to dealing with the impacts of climate change after they have taken place. Examples would include the

---

nature. A wider variety of approaches, including more non-structural (e.g., behavioral) approaches, are applicable to transportation and residential sectors. Examples include land use planning, flexible working hours to reduce traffic congestion, and moral suasion.

15. Stephen J. DeCanio, The Efficiency Paradox: Bureaucratic and Organizational Barriers to Profitable Energy-Saving Investments, 26 ENERGY POLICY 441-54 (1998); ROBERT U. AYRES AND LESLIE W. AYRES, INDUSTRIAL ECOLOGY: TOWARDS CLOSING THE MATERIALS CYCLE (Edward Elgar Pub. 1996).

16. David W. Keith, Industrial Carbon Management: An Overview (2001) (unpublished, Carnegie Mellon University) (on file with author).

17. *See* Roger Sedjo et al., *The Economics of Managing Carbon Via Forestry: Assessment of Existing Studies*, 6 ENVTL. & RESOURCE ECON. 139 (1995).

migration of species and human settlements, living with greater heat stress, or vaccinating populations against possible increases in vector-borne diseases.

6. Cost and Benefit Assessment

Simply providing a ranking of costs of various options, as in the previous item, is not enough. There is a need to specify costs and to ensure that they are comprehensive and cover the life-cycle of the option being brought into use. For example, the options should be detailed enough to factor the costs of decommissioning the nuclear power plants. The cost of various options over a broad range must be evaluated, such as interfuel substitution, which may be cheaper than tree planting for any given level, yet nevertheless, the analysis needs to be undertaken at the margin. The first few units of tree planting, which is an oft-ignored GHG reduction option, is much cheaper than the last few units of the prevalent use of interfuel substitution, thus giving the former a role in the optimal mix of options.

In addition, general equilibrium or macroeconomic impacts must be assessed. The whole may be more than just the sum of the parts, therefore macroeconomic indicators as employment and income must be evaluated.[18] Likewise, it is also important to determine impacts on the competitiveness of a region, both to assess the economy and to identify potential "leakages" of emissions moved to other locations.[19] The GHG MAP serves to illustrate the potential effects of the future sustainable economic development.

In addition to calculating aggregate cost impacts, the determination of their distribution across political jurisdictions, economic sectors and socioeconomic groups should be undertaken not only for determining fairness (e.g., environmental justice) but also for informing the stakeholder process and obtaining political support. Individual citizens, businesses and interest groups are unlikely to make decisions on the basis of how the community as a whole will be affected, but are also interested in the impact on themselves and the impacts on others in relation to the impact on themselves.[20]

While it is not always acknowledged, nearly all adaptations to

---

18. *See* Adam Z. Rose & Gbadebo Oladosu, *Greenhouse Gas Reduction Policy in the United States: Identifying Winners & Losers in a Permit Trading System*, 23 ENERGY J. 1 (2002).

19. *See* P.C. Li & Adam Z. Rose, *Global Warming Policy & The Pennsylvania Economy: A Computable General Equilibrium Analysis*, 7 ECON. SYS. RES. 151 (1995).

20. *See* Adam Z. Rose et al., *International Equity & Differentiation in Global Warming Policy*, 12 ENVTL. & RESOURCE ECON. 25 (1998).

climate change would involve either out-of-pocket costs or opportunity costs such as lost profits, inconvenience, and loss of biodiversity. These must be weighed against the cost of more explicit GHG mitigation.

Furthermore, co-benefits should also be calculated. Conservation of energy resources for the sake of reducing emissions of GHGs also reduces the amount of ordinary air, water, and solid waste pollution and at the same time improves the energy independence of the U.S. For obvious reasons, benefits of fiscal reform stemming from possible carbon tax revenues should be taken into account.[21]

7. Policy Instrument Design

Work on the cost assessment stage alone is unlikely to ensure that GHG reduction targets are met at the lowest possible cost. There are just too many calculations to undertake, and some mechanism is needed to ensure compliance. Experience has shown that a strict regulatory approach, often referred to in a perjurative way as "command-and-control" is problematic in many respects, because it would require a complete set of mitigation option cost calculations to identify the most cost-effective strategy from the top down, and because it limits freedom of choice, thereby stirring resistance. Initially only economists favored incentive-based policy instruments, however environmental policy-makers now also back the policy instruments.[22] The major examples are a GHG tax and GHG emission permits ("cap and trade"), which are roughly equivalent so long as the permits are auctioned rather than freely granted, or "grandfathered".[23] While at first glance, this may appear to give polluters too much leeway, permits have been proven effective in many applications, most notably the sulfur emission allowance trading of the Clean Air Act Amendments.[24] Essentially, permits impose an opportunity cost on emissions sources and force them to weigh the cost of releasing GHGs into the atmosphere vs. mitigating the release of the pollutants. Individual decision-makers undertake the necessary calculations. Moreover, as long as the emissions can be monitored (see

---

21. *See* Lawrence H. Goulder, *Environmental Taxation & The Double Dividend: A Reader's Guide*, 2 INT'L TAX & PUB. FIN. 157 (1995); *see also* ADAM Z. ROSE et al., THE PENNSYLVANIA STATE UNIVERSITY, INCENTIVE-BASED APPROACHES TO GREENHOUSE GAS MITIGATION IN PENNSYLVANIA: PROTECTING THE ENVIRONMENT AND PROMOTING FISCAL REFORM (2002).

22. *See* Jonathan B. Wiener, *Global Environmental Regulations: Instrument Choice in Legal Context*, 108 YALE L.J. 677 (1999).

23. John Pezzey, *Symmetry Between Controlling Pollution by Price and by Quantity*, 25 *CAN. J. OF ECON.* 983-91 (1992).

24. D. Ellerman, et al., *Market for Clean Air: The U.S. Acid Rain Program*, New York: Cambridge University Press (2000).

below), the actions are primarily self-enforcing.[25]

The Kyoto Protocol provides for such options in its "flexibility mechanisms"[26] and several studies have shown that the costs of meeting Kyoto targets can be reduced by more than 75 percent over the fixed quota approach by allowing full flexibility, such as trading across GHGs among as many participants as possible.[27]

Several other types of policy instruments are worthy of consideration, and there is nothing wrong with using a combination. These include high profile praise for voluntary action, such as Bush administration's Energy Star Program,[28] credits for early action, joint implementation projects, emission reduction efforts sponsored by industrialized countries in transitional or developing countries, and mandates in areas such as renewable portfolio standards and government green purchase commitments. Other policies relating to the ordinary workings of government can be effective as well, including land-use and transportation planning, bonding authority, tax credits, public utility pricing, and municipal waste management.[29] The opportunities for cost-savings from incentive-based instruments are not as large at the small area scale, because the greatest possible gains exist where mitigation costs differ sizably across emitters, and this is less likely to be the case in areas with a more narrow economic base (e.g., compare the amount of trading in the electric utility-focused U.S. sulfur emission allowance program to the projection of the much larger global GHG market). There are other ways to lower the cost, including extending across political boundaries, as in the recent New England Governor's Association plan.[30]

---

25. T. Tietenberg, and D. Victor., *Possible Administrative Structures and Procedures for Implementing Tradeable Entitlement Approach to Controlling Global Warming*, *in* T. Tietenberg et al., *Combating Global Warming: Possible Rules, Regulations, and Administrative Arrangements for a Global Market and CO_2 Emission Entitlements*, New York: United Nations (1994).

26. Kyoto Protocol to the United Nations Framework Convention on Climate Change, *adopted* Dec. 11, 1997, 17 I.L.M. 22.

27. *The Costs of the Kyoto Protocol: A Multi-Model Evaluation*, ENERGY J, May 1999; J. Reilly et al., *Multi-Gas Assessment in the Kyoto Protoco*, 401 NATURE 549-55 (1999); Adam Rose & Brandt Stevens, *An Economic Analysis of Flexible Permit Trading in the Kyoto Protocol*, 1 INT'L ENVT'L AGREEMENTS: POL., LAW & ECON. 219-42 (2001); Rose & Oladosu, *supra* note 18.

28. Executive Office of the President, *National Energy Policy: Reliable, Affordable, and Environmentally Sound Energy for America's Future*, Report of the National Energy Policy Development Group, Washington, DC: U.S. GPO (2001), *available at* http://www.whitehouse.gov/energy/National-Energy-Policy.pdf.

29. Nancy Rader and Richard Norgaard, *Efficiency and Sustainability in Restructured Electricity Markets: The Renewables Portfolio Standard*, 9 Electricity Journal 37, 37-49 (1996); *see also* examples in CENTER FOR CLEAN AIR POLICY, *supra* note 1.

30. CENTER FOR CLEAN AIR POLICY, *supra* note 1.

The timing of implementation, including borrowing and banking permits, is yet another way of reducing costs. This allows time for normal construction instead of more costly retrofit, as well as technological change to take place.

8. Equity and Burden-Sharing

Most climate change impacts impose a burden that is not evenly distributed across regions, sectors, and socioeconomic groups. Likewise, the distribution of costs and other economic impacts differs. The cost-effective outcome is unique[31], meaning there is a single best combination of mitigation actions, though they may be very unevenly distributed. It would seem that this would clearly identify who bears the cost burden, but there are several ways this can be adjusted to meet other goals, such as equity, or fairness. The least-cost outcome under an incentive-based system rewards those with the greatest ability to minimize the tax payments or to sell permits.[32] Still, entities that are hit especially hard might be compensated, both for the sake of fairness and pragmatism in receiving their cooperation.[33] Tax revenues can be redistributed in a similar manner. Finally, assignments of grandfathered permits can be varied significantly across entities according to various equity principles relating to permit allocation or welfare outcome.[34]

One of the sticking points, however, is in the definition of equity. While most people agree on the definition of economic efficiency, there is no universal consensus on the definition of equity, at the interpersonal, interregional, or international levels. More than two-dozen principles have been put forth for climate change policy[35] and more are possible in applying them to reference bases other than emissions (e.g., energy use). Still, although many equity principles differ in theory, the distributional

31. Ronald Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

32. Gbadebo Oladosu & Adam Z. Rose , "The Income Distribution Imparts of Climate Change Mitigation Policy in the Susquehanna River Basin," The Pennsylvania State University, University Park, PA (2002), *available at* http://www.ace.uiuc.edu/pERE/conference/papers/rose.pdf.

33. D. Harrison, *The Distributive Effects of Economic Instruments for Environmental Policy*, Org. for Econ. Co-opertaion & Dev. (Paris 1994); A. L. Bovenberg and L. H. Goulder, *Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost,*Resources for the Future Discussion Paper (Washington, DC 1999).

34. Rose et al., *supra* note 20.

35. J. Thompson, et al., *Cultural Discourses, in* Human Choice and Climate Change: An International Social Science Assessment 287 (S. Rayner & E. Malone eds. 1997); D. Brown, AMERICAN HEAT: ETHICAL PROBLEMS WITH THE UNITED STATES' RESPONSE TO GLOBAL WARMING 95 (Rowman & Littlefield 2002); B. Solomon & R. Lee, *Emissions Trading Systems and Environmental Justice*, 42 ENV'T 32-45 (2002).

outcome of their application is quite similar, thereby reducing potential tensions at the bargaining table.[36]

9. Policy Dividends

In addition to preventing damage from climate change, carbon tax revenues or permit auction revenues can be used for investment and fiscal/budgetary policy reform.[37] Alternatives include deficit reduction, expenditure expansion, including investment in research and development or subsidies for desired action, and the return of revenues to emitters, including compensation, and tax relief both individual and corporate.

Moreover, most ordinary taxes are distortionary in that they alter prices that are intended to reflect value in the marketplace. On the other hand, environmental taxes, including permits, are intended to offset the distortion that exists when environmental resources are under-valued. Therefore, the reduction of existing distorting taxes has the potential to result in an efficiency gain and stimulates the economy, offsetting negative cost impacts partially, or even more than fully. This is one example of what is often referred to as the "double-dividend" of environmental taxation.[38]

10. Geographic Scale and Jurisdictional Issues

With the information and analyses developed thus far, policy-makers will now be able to address key issues relating to the appropriate geographic level or mix of levels for dealing with the GHG emission problem. Every emitter simultaneously lives in several, telescoping political areas, and the inter-jurisdictional tensions in developing a GHG MAP are likely to be as great as in any other serious issue we face today, and perhaps even more so given spillover effects at the root of the problem and inherent in its solution.

Extensive analyses of issues of scale have been undertaken.[39] These insights should be used to identify the most appropriate scale for the

---

36. A. Rose and Z. Zhang, *Mitigation and Adaptation Strategies for Global Change*, forthcoming (2004).

37. Goulder, *supra* note 21.

38. I. Parry, et al., *When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorte Factor Markets*, 37 J. OF ENVTL. ECON. & MGMT. 52-84 (1999); F. Bosello, et al., *The Double-Dividend Issues: Modeling Strategies and Empirical Findings*, ENV'T & DEV. ECON. 9-45 (2001).

39. Robert W. Kates & Ralph D. Torrie, *Global Change in Local Places*, ENVIRONMENT, Mar. 1998, at 39; ASSOCIATION OF AMERICAN GEOGRAPHERS GLOBAL CHANGE IN LOCAL PLACES RESEARCH TEAM, GLOBAL CHANGE AND LOCAL PLACES (Cambridge Univ. Press 2003).

design, implementation, monitoring, and assessment of a GHG MAP. By law and tradition, state government, as opposed to sub-state entities, are likely to take the lead. This is justified for reasons of resources, expertise, and comprehensiveness. However, the issue may be global and jurisdictional authority may be at the state level, but the dictum that "all politics is local" may also be most relevant here based on the emphasis on stakeholder involvement, the need for voluntary cooperation, and the significance of location decisions.

It is desirable that counties, cities, and relevant special purpose districts develop GHG MAPs at some point in the process. In fact, an iteration of planning is likely to ensue. In reference to stakeholders, we have typically referred to businesses and NGOs, but local political jurisdictions tend to be even more influential. The development of a GHG MAP will be helpful for these entities to assess their role, and will be most helpful in the implementation of a state level Plan. Of course, sub-state political jurisdictions have few resources and therefore need not develop a GHG MAP as extensive as that aforementioned proposed to be effective.

One consideration stands out as far as the advantage of interjurisdictional cooperation that surpasses the sub-state level. Interjurisdictional contact is valuable for information exchange and lobbying efforts. For instance, insights from other cultures prove valuable, such as in the advances in technology and behavioral response in Europe and Japan, which have led them to be able to sustain healthy economies with less than half the energy utilization of the U.S. At the same time, the U.S. has provided leadership in innovation in incentive-based policy instruments that it can share with others. Also, as noted earlier, inter-jurisdictional cooperation holds the prospect of making some policy approaches more effective (e.g., the lowering of overall mitigation costs in an emission permit trading system).

11. Specifying Targets and Timetables

Models can help identify a least-cost strategy using principles that are available to guide the adjustment of costs to individual emitters to an equitable outcome. However, decisions for the final GHG emission targets and distribution are likely to be dominated by a stakeholders' negotiating process guided by government officials. Self-interest neither can be denied nor should it be denied in many respects. The decision process can be aided by moving beyond a narrow view of self-interest, if stakeholders are made clearly aware of benefits to them and their communities stemming from GHG mitigation and the consequences of inaction. Moreover, participants will likely not need a reminder that if the process does not make progress, the government will be forced to take a more central role.

Given the extensive number of "no regrets" options, for example, energy conservation that pays for itself, emitters are likely to cooperate on at least some meaningful cutbacks in GHGs initially during the first phase of emission reduction. Over time, higher emission reduction requirements are inevitable to stabilize, let alone reduce, atmospheric concentrations of greenhouse gases. This will involve hard choices, and targets are likely to be more the purview of government officials and scientists than of emitters. Of course, a negotiation process can still determine how the target reductions are distributed among the emitters. Also, the manner in which an individual emitter achieves its target is best left to free choice on political and economic grounds.

Providing information from actual experience of business and other institutions on improved economic conditions through modification of technology or operating behavior will help in advancing beyond the starting point of the more obvious "no regrets" options.[40] Many other emitters can be brought on board by the prospects of reduced cost through permit purchases, not to mention from permit sales or a return of carbon tax revenues, directly or through reductions in corporate or individual income taxes. Others will be coaxed by the need to maintain a good company image in an era where being perceived as "Green" is good for business.[41]

If the command and control approach is used, emission reduction targets or emission caps should be clearly specified on an individual emitter basis to the extent possible. All of these targets need not be rigid, but can also allow for economic growth and special circumstances. If the permit approach is used, specification of an overall total of permits (essentially the emissions cap) is the starting point.

Bidders will then come forth when individual emitters are also assigned an emissions reduction cap, or quota. They will purchase permits, establishing a single market price for permits, to avoid in total or in part undertaking the necessary reduction in emissions to meet the cap on their own through mitigation. If permits are to be freely granted, principles of allocation need to be specified, as must any limitations on trading. However, limitations on trading are to be discouraged, because they reduce the cost-saving potential of this instrument.[42] If a carbon tax

40. ROBERT U. AYRES AND LESLIE W. AYRES, *supra* note 15.

41. Thomas H. Tietenberg & David Wheeler, *Empowering the Community: Information Strategies for Pollution Control*, *in* FRONTIERS OF ENVIRONMENTAL ECONOMICS 85 (Henk Folmer et al. eds., Edward Elgar 2001).

42. Adam Rose & Brandt Stevens, *supra* note 27.

is to be used, policy-makers will need reasonably accurate estimates of GHG mitigation costs so that the tax can bring about the intended emission reductions.

The timetable for compliance should also be clearly specified and include rewards for early action and penalties for failure to meet obligations. Distinctions should be made between actions that are immediately feasible and those that will best be undertaken in the mid- to long-range.[43] Any provisions for trading over time, such as self-banking or borrowing of permits or even of fixed quotas, should be clearly spelled out. Provisions for the periodic reassessment of targets should be included in the process, as discussed below.

12. Institutional Support

GHG mitigation planning requires extensive resources, and time to design, implement, assess, monitor, and refine that plan to guarantee formal institutional support. This begins with government officials being formally assigned to the effort and receiving the necessary support services. It is imperative that the staff has expertise on the topic. Coordination with other units of government at all levels and with various stakeholders is also critical.[44] Resources already in place (e.g., transportation departments, zoning boards) can be helpful to the effort, and their cooperation is a must if inconsistent policies are to be avoided.

Some of the major non-governmental resources can be tapped from the private and non-profit sectors. For example, the Pennsylvania Consortium on Interdisciplinary Environmental Policy[45] has successfully brought together researchers from nearly 60 institutions of higher learning in the State to contribute to analyzing and acting on a broad range of environmental issues, including climate change. The PCIEP offers access to expertise on an "as needed" basis without tying up resources in long-term commitments, as in the hiring of employees.

13. Implementation

The targets and timetables for GHG mitigation need to be codified into laws and regulations that reflect the goals of the GHG MAP and the realities of day-to-day activities of society. Building on the current legal framework, supplemented with legislation to shore up and enhance it, can facilitate this.[46] Key actions might include legislative approvals of a

43. STATE AND LOCAL CLIMATE CHANGE PROGRAM, *supra* note 3.
44. *Id.*
45. PCIEP, *supra* note 8.
46. John Dernbach and the Widener University Law School Seminar on Global

carbon tax, and legislative and administrative decisions on permit auction/carbon tax revenue utilization. Also necessary is the codification of special rules for various policy instruments. An example would be the specification of emission permits and their exchange, as well as certification of offsetting emission reductions by permit sellers. A trading mechanism must also be established, but this can be accomplished by the private sector through a regulated exchange (e.g., the Chicago Board of Trade as in the sulfur allowance trading program).[47]

Mechanisms need to be enacted to monitor and enforce the Plan as well, though it should be kept in mind that studies have shown that voluntary reporting can be very effective.[48] These efforts have typically begun with the establishment of an emissions registry.[49] Its scope need not be confined to just direct emissions but might also include indirect ones stemming from purchased electricity, land filling of wastes, employee business travel, and transportation of inputs and products.[50] Of course, care must be taken to avoid double counting.

14. Measuring Progress

Slowing climate change requires a sustained effort with no end in sight, given that GHG emissions can realistically never be reduced to zero and are a cumulative pollutant, thereby remaining in the atmosphere for decades. By allowing emitters lead-time to adjust and comply with regulations, substantial cost savings are reaped despite the stretching out of the clean-up process.

Warming, *Moving the Climate Change Debate From Models to Proposed Legislation: Lessons From State Experience*, 30 ENVTL. L. REP. (Envtl. L. Inst.) 10933-79 (2000); *see* STATE AND LOCAL CLIMATE CHANGE PROGRAM, OFFICE OF POLICY *supra* note 3 at 2-17 (explaining state policy statements for climate change responses).

47. This might also involve the elimination of current laws and regulations that are at odds with GHGs MAP objectives, such as the required flaring of methane from landfills in some state. *See supra* note 3. National (federal) level considerations are important implementation. In addition incentive-based policy instruments, noted earlier, there are a range of national considerations that need to be considered. *See* U.S. Environmental Protection Agency, *States Guidance Document: Policy Planning to Reduce Greenhouse Gas Emissions, Second Edition,* Chapter 7 (May 1998), *available at* http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUMXF/$File/guid_doc.pdf.

48. Thomas H. Tietenberg & David Wheeler, *supra* note 41.

49. *See* Northeast States for Coordinated Air Use Management,*State GHG Registry Collaborative: Registry Issues and Options* (March 2002), *available at* http://www.nescaum.org/Greenhouse/Registry/reporting.pdf.

50. WORLD RESOUCES INSTITUTE & WORLD BUSINESS COUNCIL FOR SUBSTAINABLE DEVELOPMENT, *The Greenhouse Gas Protocol: Corporate Accounting and Reporting Standard* (Washington, D.C. 2001).

First, it is necessary to establish an emissions "baseline" for each GHG against which to measure progress.[51] The compilation of a GHG emission inventory is not sufficient because of lags in data collection and refinement. Some methods of projection are needed as is a system for tracking emissions over time. The issue of "additionality," or making sure that reductions stem from more than just ordinary business practice, must be addressed. It is also important to assess whether reductions in a given jurisdiction are real, or simply leak elsewhere with the shift in economic activity.

Individual and emitter macroeconomic costs should be monitored. Technology assessment also falls under this heading, including the evaluation of demonstration projects. This involves aspects of certification, verification, and auditing, and offers a major role for NGOs as neutral third parties.[52]

Finally, in measuring compliance, it is important to ascertain if and why prior compliance has fallen short and to apply the information in pursuit of developing remedies to improve it. Co-benefits should also be evaluated in terms of reduction in other types of environmental damage, attainment of other environmental sustainability goals, fiscal/budgetary reform, and energy self-sufficiency.

15. Ongoing Reassessment

Many conditions associated with a GHG MAP change rapidly, including scientific evidence on climate change and its impacts, as well as on technology and costs. This is the foundation for assessing whether targets, timetables, and policy instruments need to be refined. Those actually responsible for developing and implementing GHG MAPs can provide valuable information to scientists and engineers in identifying the most effective areas in which to reduce uncertainty and improve technology. This also pertains to feedback from those collecting and disseminating data.

The administrative structure of the GHG MAP also needs to be reevaluated to determine whether it has maintained an open process, actively engaged stakeholders, achieved compliance, and minimized bureaucratic delays and costs. New innovations should be evaluated and considered for incorporation in the plan.

Major changes in the GHG MAP must be managed carefully,

---

51. S. Kerr, *An International Tracking System for Greenhouse Gas Trading, in* GLOBAL EMISSIONS TRADING (Kerr ed. 2000).

52. Northeast States for Coordinated Air Use Management, *State GHG Registry Collaborative: Registry Issues and Options* (March 2002), *available at* http://www.nescaum.org/Greenhouse/Registry/reporting.pdf., *supra* note 49.

because nothing is more unsettling to emitters, and is likely to undercut cooperation and compliance more than changes in targets and regulations, even if they are minimal. Such changes increase the risk of involvement, which often translates into added costs, or at least the perception of wasted effort. The establishment of long-term targets, credits for early action, and good forecasting of climate change, GHG emissions, and general economic conditions can head these problems off somewhat.

16. Education and Outreach

The new information on climate change, its impacts, and its mitigation costs should be disseminated to the citizenry to obtain their input, general political support, and day-to-day compliance. The educational process can take a number of forms, including public hearings, conferences, and print, film, and electronic media. Given the long term and fundamental nature of the problem, the dissemination of information should be oriented toward both primary and secondary education.

Outreach should be specially targeted to those most vulnerable to the impacts of climate change (e.g., the elderly) and those whose cooperation will be most important in mitigating it (e.g., large energy users). While the focus is often on private industry, it should be remembered that households, primarily through their driving behavior, are major contributors to the problem, and hence to its solution. In both cases, one of the most effective ways of gaining support is the dissemination of success stories on demonstration projects and low-cost mitigation efforts.

Ways of accommodating feedback from education and outreach efforts are important in improving compliance coupled with the evaluation of the major features of the GHG MAP, such as targets, timetables, monitoring, and enforcement. Given advances in technology, there is no reason that this process cannot take place in real time, as in the development of an interactive website on climate change.[53]

17. Emergency Action

While the emphasis is typically on long-term climate change, scientists have a basis for believing the problem also extends to short-term climate variability, as in the increased frequency and magnitude of severe storms, including hurricanes. Scientific research is beginning to

53. *Consortium for Atlantic Regional Assessment, at* http://www.cara.psu.edu.

link the increased prevalence of vector-borne diseases to higher temperatures and rainfall, leading to the possibility of serious disease outbreaks. For instance, heat waves in urban areas with poor coping mechanisms caused by poor ventilation and lack of air conditioning fall into this category.[54]

While the GHG MAP is unlikely to include actual emergency services to deal with these problems communication between the policy-makers, researchers, and government staff members dealing with climate change and those providing emergency services can help in the long-term design and prediction of emergency events. A similar process also pertains to chronic climate change issues, such as sea-level rise (land-use planning) and higher temperatures (energy and technology planning). Increasingly, the private sector is realizing the potential devastating effects of climate change and climate variability and the benefits in contributing to reducing the emission levels. Witnessed most directly is the devastating impact of the increase in severe storms in damaging commercial forests,[55] and indirectly witnessed, is the burden caused by the interruption of electricity.[56]

III. Conclusion

As reflected in this paper, a GHG MAP is similar to a relay team, in that it requires a strong effort by everyone, and the race can be lost if any single member under-performs. However, unlike a relay race, many of the stages can be performed in parallel, and on-going feedback is valuable. Also, track conditions are constantly changing, including the perception of constantly having to run uphill. Participants in the development of a GHG MAP will need inspiration to stay the course. Keeping in mind the dire consequences of inaction can serve as an important first compass point.

---

54. NATIONAL ASSESSMENT SYNTHESIS TEAM, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change* (2001).

55. D. DeWalle & A. Buda, *Effects of Extreme Weather on Forest Land Management Within the Mid-Atlantic Region* (The Pennsylvania State Univ. Environmental Resources Research Institute, 1999).

56. Adam Rose, *A Critical Issue in Electricity Reliability: Minimizing Regional Economic Losses in the Short Run*, INT'L ASS'N FOR ENERGY ECON. NEWSLETTER, First Quarter, 2001 at 14, 15, 29.