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Toward a Climate Change Strategy for Pennsylvania

John C. Dernbach

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Human-induced climate change is one of the greatest environmentally-related challenges of the coming decades, if not the greatest challenge. While climate change has global and national ramifications, it also has serious consequences for states. Pennsylvania will experience significant warming in the coming century, and the negative consequences of this warming will be much greater than the positive consequences. Nor is the national government likely to protect Pennsylvania from those consequences. The United Nations Framework Convention on Climate Change provides an international legal structure to address climate change,[1] and the United States is a party to that Convention.[2] The Kyoto Protocol to that Convention would have the United States and other developed countries reduce their greenhouse gas emissions,[3] but the United States has decided not to participate in the Protocol.[4] As a result, a serious national effort to adopt and implement

* Professor, Widener University Law School. Don Brown and John Hanger contributed ideas to this article. Please send comments or questions to john.c.dernbach@law.widener.edu. After preparing this article, the author became Director, Office of Policy, Pensylvania Department of Environmental Protection (DEP). The views expressed in this article are those of the author, and do not necessarily represent those of the DEP.

1. *United Nations Framework Convention on Climate Change*, U.N. Doc. A/AC.237/18 (1992), *reprinted in* 31 I.L.M. 849 (1992) [hereinafter Framework Convention].

2. The United States was the fourth country to submit its articles of ratification. Framework Convention on Climate Change–Secretariat, *United Nations Framework Convention on Climate Change: Status of Ratification of the Convention, available at* http://www.unfccc.de/resource/conv/ratlist.pdf, *(last Modified on: Feb. 17, 2003).*

3. *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, U.N. Doc. FCCC/CP/1997/L.7/Add. 1 (1998), *reprinted* in 37 I.L.M. 22 (1998).

4. Letter from President George W. Bush to Senators Hagel, Helms, Craig and Roberts (March 13, 2001), *available at*

laws and policies to address climate change does not appear likely.

An important part of Pennsylvania's response to climate change is its choice of legal and policy instruments. Any effort to address climate change needs to include adaptation to climate change, reduction in greenhouse gas emissions, and sequestration or storage of carbon that would otherwise be emitted into the atmosphere in the form of carbon dioxide (the most prevalent greenhouse gas). For each of these objectives, a great many legal and policy instruments are available. Of equal importance, however, some of these instruments are also capable of producing additional or ancillary benefits. These include, but are not limited to, creation of goods and services (e.g., energy conservation, energy efficiency, renewable energy) for which there are significant and growing domestic and international markets, technological innovation, job creation, financial savings to customers and businesses, and reduction in air pollutants other than greenhouse gases. Climate change is not simply a matter of reducing and adapting to risks; it can also be used to maximize opportunities and benefits. These opportunities and benefits are best realized if the state acts strategically.

Part I of this Article provides a basic overview of the scientific information concerning climate change, including likely impacts of climate change on Pennsylvania, and suggests a context for understanding that information. A key conclusion from Part I is that Pennsylvania will be significantly affected whether it reduces greenhouse gas emissions or not; adaptation will necessarily be part of any Pennsylvania response. Part II explains why the state should act, and outlines the need for a comprehensive strategy that looks at all economic sectors and all sources of greenhouse gas emissions. As argued in Part II, Pennsylvania should choose from a range of legal and policy instruments to reduce risks and maximize benefits.

I. What The Science Tells Us

A. Projected Impacts

1. World

A scientific consensus exists concerning the reality and significance of human-induced climate change. This consensus is based to a great degree on the reports of the Intergovernmental Panel on Climate Change (IPCC), which provides the most authoritative scientific information about global climate change. The IPCC was created in 1988 by the

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http://www.whitehouse.gov/news/releases/2001/03/20010314.html. (last visited on Oct. 9, 2003).

World Meteorological Organization and the United Nations Environment Program to assess "scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change."[5] In 1996, the IPCC concluded that the "balance of evidence suggests a discernible human influence on global climate."[6] In 2001, in its most recent report, the IPCC found "new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."[7] Two of the most certain effects of human-induced climate change are higher average surface temperatures and rising sea levels. Both of these effects can be explained in a straightforward way.

During the 20th century, IPCC found, average surface temperatures around the world increased by about 0.6 degrees Centigrade (or about 1.0 degree Fahrenheit).[8] This increase, IPCC said, "is likely to have been the largest of any century during the past 1,000 years."[9] The word "likely" in this assessment indicates a 66 to 90% chance that a particular statement is true.[10] The atmospheric concentration of carbon dioxide has increased by almost one third since 1750. We now have the highest carbon dioxide concentration in the past 420,000 years, and are likely to have the highest concentration in the past 20 million years.[11] Carbon dioxide and other "greenhouse" gases trap radiation from the sun in proportion to their atmospheric concentration; higher concentrations of such gases trap more energy than lower concentrations.[12] This increase in carbon dioxide concentrations is due primarily to the burning of fossil

5. Intergovernmental Panel on Climate Change, *About IPCC, available at* http://www.ipcc.ch/about/about.htm (visited Oct. 9, 2003).

6. D.L. ALBRITTON ET AL., *SUMMARY FOR POLICYMAKERS*, *in* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS 10 (J.T. Houghton et al. eds., 2001) (quoting report).

7. J.F.B. Mitchell et al., *Detection of Climate Change and Attribution of Causes*, *in* CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS, at 698. "The increase in the number of studies, the breadth of techniques, increased rigor in the assessment of the role of anthropogenic forcing in climate, the robustness of results to the assumptions made using those techniques, and consistency of results lead to increased confidence in these results." *Id.*

8. *See* D.L. ALBRITTON ET AL., *supra* note 7 at 2.

9. *Id*.

10. *Id*. at 2 n.7.

11. *Id*. at 7. The atmospheric concentration of another greenhouse gas, methane, have increased by 151% since 1750. *Id*.

12. D.L. ALBRITTON ET AL., *supra* note 6, at 24. The radiative characteristics of each gas, and the ways in which gases interact in the atmosphere, also affect outcomes. *Id*. For example, a ton of methane has much more global warming potential than a ton of carbon dioxide. V. RAMASWAMY ET AL., *Radiative Forcing of Climate Change*, *in* CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS, *supra* note 7, at 386-88. Higher concentrations of carbon dioxide and methane are likely to lead to warming than higher concentrations of either gas alone. Higher concentrations of other gases, on the other hand, somewhat offset the warming potential of these gases. D.L. ALBRITTON ET AL., *supra* note 6, at 37.

fuels.[13] Thus, "most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations."[14]

Average sea levels around the world increased between 0.1 and 0.2 meters, and the oceans themselves have been warming for at least half a century.[15] Because sea water expands as it gets warmer, and because of the widespread melting of glaciers and other land ice during the 20th century, "it is very likely that the 20th century has contributed significantly to the observed sea level rise."[16] The term "very likely" in the report indicates a 90 to 99% chance that a particular statement is true.[17]

For the 21st century, the IPCC concluded that carbon dioxide emissions from fossil fuel burning "are virtually certain to be the dominant influence" on atmospheric emission trends.[18] "Virtually certain" is IPCC language for a result that has more than a 99% chance of being true.[19] Because the future cannot be predicted, IPCC developed six sets of scenarios, or plausible future climates, based on different assumptions about human activity.[20] Between 1990 and 2100, global average surface temperatures are projected to increase, under all IPCC scenarios, by 1.4 to 5.8 degrees Centigrade (or about 2.5 degrees Fahrenheit to 10.5 degrees Fahrenheit).[21]

This temperature increase has other consequences as well. Global average water vapor concentrations (humidity) and precipitation are also projected to increase.[22] Similarly, sea level is projected to rise under all scenarios by 0.09 to 0.88 meters.[23] In addition, "[h]igher maximum temperatures and more hot days over near all land areas" are considered "very likely" in the 21st century. An increase in the heat index, a measure of temperature and humidity for human comfort, is considered "very likely" for most areas. "More intense precipitation events" are considered "very likely" for many areas.[24] Greater continental drying and drought risk in summers are "likely" over "most mid-latitude

13. I.C. PRENTICE, *The Carbon Cycle and Atmospheric Carbon Dioxide, in* CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS, *supra* note 6, at 184. Land use changes account for most of the rest of the increase. *Id.*
14. D.L. ALBRITTON ET AL., *supra* note 6, at 10.
15. *Id. supra* note at 4.
16. *Id*. at 10.
17. *Id*. at 2 n.7.
18. *Id*. at 12.
19. D.L. ALBRITTON ET AL., *supra* note 6, at 2 n.7.
20. *Id*. at 14, 18.
21. *Id*. at 13.
22. *Id*.
23. *Id.* at 10.
24. *Id*. at 15.

continental interiors."[25]

2. Pennsylvania

Two reports have assessed the probable effects of climate change in Pennsylvania. One of these is *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, an assessment of U.S. effects that was recently published by the U.S. Global Change Research Program.[26] This report contains an assessment for each region of the United States, including the northeast.[27] The northeast region extends from West Virginia and Maryland to Maine, and includes Pennsylvania, New York, and New Jersey.[28] The second report focuses on the Mid-Atlantic region alone.[29] The Mid-Atlantic region runs from the northern part of North Carolina to part of southern New York, and includes Pennsylvania, Virginia, West Virginia, Maryland, Delaware, and part of New Jersey.[30] Both assessments rely largely on the same two computer models. The lower projected impacts are derived from the model showing the least warming in this region, while the higher projected impacts are deduced from the model that shows the greatest warming.[31] The projections of greenhouse gas emissions and warming in both models are approximately in the

25. D.L. ALBRITTON ET AL., *supra* note 6, at 15.

26. The report was published in shorter and longer versions. The longer version is U.S. National Assessment Synthesis Team Global Climate Change Research Program, *Climate Change Impacts on the United States: The Potential Consequence of Climate Variability and Change*, Foundation (2001), *available at* http://www.gcrio.org/NationalAssessment/foundation.html [hereinafter FOUNDATION]. The shorter version is National Assessment Synthesis Team, U.S. Global Climate Change Research Program, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, Overview (2000), *available at* http://www.gcrio.org/NationalAssessment/overpdf/overview.html [hereinafter OVERVIEW].

See also Stewart Cohen & Kathleen Miller, *North America*, *in* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 2002: IMPACTS, ADAPATION, AND VULNERABILITY 735 (James J. McCarthy et al. eds. 2001) (assessing climate change impacts on North America, including United States).

27. FOUNDATION, *supra* note 26, at 109-34; OVERVIEW, *supra* note 26, at 40-45.

28. OVERVIEW, *supra* note 26, at 40 (map of northeastern region).

29. MID-ATLANTIC REGIONAL ASSESSMENT TEAM, PENN STATE UNIVERSITY, PREPARING FOR A CHANGING CLIMATE: MID-ATLANTIC OVERVIEW (2000) [hereinafter MID-ATLANTIC ASSESSMENT].

30. *Id*. at i.

31. The models are the Hadley model (developed by the Hadley Centre for Climate Change Prediction and Research in Great Britain) and the CCC model (from the Canadian Centre for Climate Modeling and Analysis). *Id*. at ii; FOUNDATION, *supra* note 27, at 32, 41. The Canadian model projects more warming than the Hadley model. *Id*. at 32.

midrange of the various scenarios developed by the IPCC.[32]

Average temperatures in Pennsylvania are projected to increase approximately two to three degrees by 2030, and approximately five to ten degrees Fahrenheit by 2100.[33] These increases would apply year around, day and night, although average winter temperatures are projected to increase somewhat more than average summer temperatures.[34] The number of summer days when the temperature exceeds 90 degrees Fahrenheit could double.[35] In addition, the summer heat index, which is a better measure of physical stress than temperature alone, is likely to increase more than the temperature.[36] The likelihood of temperature increases is described as "high."[37] Moreover, these increases are in addition to the 1.2 degree Fahrenheit increase in Pennsylvania that has already occurred over the past century.[38] As significant as these increases may appear, they are among the lowest projected warming increases in the United States.[39]

These temperature increases are likely to have adverse human health consequences. Heat-related summer deaths in Philadelphia and Pittsburgh are projected to increase from about 190 per year to between 350 and 790, although the increase in summer deaths may be partially offset by a reduction in winter deaths.[40] In addition, warmer temperatures are likely to lead to increased concentrations of ground-level ozone,[41] a pollutant that is directly regulated under the Clean Air Act because of its ability to harm human health.[42] There may also be an increase in vector borne disease, such as West Nile virus, encephalitis, and Lyme disease.[43]

Species and ecosystems are also likely to be affected. Although

32. OVERVIEW, *supra* note 26, at 5.

33. MID-ATLANTIC ASSESSMENT, *supra* note 30, at 14; FOUNDATION, *supra* note 27, at 113.

34. FOUNDATION, *supra* note 26, at 113-14.

35. *Id*. at 123.

36. FOUNDATION, *supra* note 26, at 443-45.

37. MID-ATLANTIC ASSESSMENT, *supra* note 29, at 17.

38. U.S. ENVIRONMENTAL PROTECTION AGENCY, CLIMATE CHANGE AND PENNSYLVANIA 3, *available at* http://yosemite.epa.gov/oar/globalwarming.nsf/uniqueKeyLookup/SHSU5BVMDY/$file/pa_impct.pdf?OpenElement (last visited Dec. 11, 2002) (based on temperature recordings in Harrisburg).

39. FOUNDATION, *supra* note 26, at 110.

40. MID-ATLANTIC ASSESSMENT, *supra* note 29, at 36.

41. FOUNDATION, *supra* note 26, at 123-24; MID-ATLANTIC ASSESSMENT, *supra* note 29, at 38.

42. 42 U.S.C. § 7408-9 (2003); 40 C.F.R. § 50.9 (2003).

43. MID-ATLANTIC ASSESSMENT, *supra* note 29, at 35-37; FOUNDATION, *supra* note 26, at 128 (explaining that public health system may be able to respond effectively to these problems, albeit with higher costs).

some species and ecosystems will be less affected by warming than others, warming is likely to reduce overall biodiversity.[44] There is "potential for very large negative impacts on Mid-Atlantic Region biodiversity, especially because many plants cannot migrate quickly and because plants and animals may not be able to negotiate barriers such as mountains, cities, or sea walls."[45] Maple, beech, and birch forests would be replaced over time by oak, ash, hickory, and pine.[46] Autumn foliage would be less colorful, with corresponding effects on tourism.[47] Warming is also likely to substantially limit the number and geographic range of brook and brown trout in Pennsylvania.[48]

Sea levels are projected to rise 4 to 12 inches by 2030, and 15 to 40 inches by 2100.[49] If rising sea levels mean that salt water moves further up the Delaware River basin, Philadelphia and other cities in the basin may be forced to seek water elsewhere.[50] The Chesapeake Bay, which is immediately south of Pennsylvania and which provides many economic and recreational opportunities to Pennsylvania residents and businesses, will also experience greater stresses as a result of rising sea levels. These stresses include the effect of higher temperatures on fish, loss of wetlands and marshes, and greater erosion.[51]

Overall, both models indicate that precipitation is likely to increase by as much as 25% by 2100.[52] The effect of warming on extremes in rainfall and other weather, however, is less clear. Droughts may become more frequent.[53] There may be an increased risk of floods.[54] Water systems may face more disruptions from drought, flash floods, storms, and electricity outages.[55] Hurricanes historically have been the top-ranked cause of severe weather damage in the region.[56] Population growth greatly increases the potential human and property damage from a hurricane. The "potential for hurricane damage in the Northeast from a single storm far exceeds the region's total damages from hurricanes over the past 40 years," and could "easily exceed twice the level of insured

44. MID-ATLANTIC ASSESSMENT, *supra* note 29, at 33 (stating that consequences for ecosystem functioning and "functions that humans value" are uncertain).
45. *Id*. at iii.
46. *Id*. at 21; FOUNDATION, *supra* note 26, at 126-27.
47. FOUNDATION, *supra* note 26, at 127.
48. *Id*. at 128.
49. MID-ATLANTIC ASSESSMENT, *supra* note 29, at 14.
50. FOUNDATION, *supra* note 26, at 123.
51. *Id*. at 120-22.
52. MID-ATLANTIC ASSESSMENT, *supra* note 29, at 14; FOUNDATION, *supra* note 26, at 110.
53. FOUNDATION, *supra* note 26, at 119-20.
54. *Id*.
55. *Id*. at 123.
56. *Id*. at 119.

damages."[57] Within the scientific community, a debate exists about whether warming will lead to an increase in the number or intensity of hurricanes.[58] As a result, the potential for greater hurricane damage from warming is a "significant concern," even though greater damage may or may not occur.[59]

The effects of climate change are not likely to be distributed evenly. Health effects, for example, are likely to fall more heavily on low-income persons, children, older persons, and persons with chronic respiratory problems.[60] In addition, while it is likely that Pennsylvania generally is likely to be able to afford the costs of adaptation,[61] there will be economic costs. In some cases, particularly for vulnerable persons and businesses, these costs could be significant.[62]

There may be some benefits from warming, at least in the 21st century. These include slight increases in production of certain agricultural crops, a reduction in cold-related winter deaths, and a slight increase in available water because of increased precipitation.[63] But on balance, the "benefits are fewer and smaller than potential damages."[64]

Moreover, adaption is not a one-time occurrence. As temperatures and sea levels rise through the 21st century and afterwards, a continuing series of adaptive measures is likely to be required. The costs of such measures are not included in these assessments, but it would be hard to describe them as nominal. In general, if concentrations of atmospheric greenhouse gases continue to increase, the effects of global warming are projected to become more severe with each passing decade. This is particularly true because, while 2100 represents the endpoint in *calculated* impacts, it does not represent the endpoint in *actual* impacts. As long as greenhouse gas emissions keep increasing, average atmospheric temperatures and sea level will continue to rise. In fact, they may continue to rise for some time after atmospheric greenhouse gas concentrations have been stabilized. As a result, little evidence exists to suggest that the projected benefits of climate change will

57. *Id*.
58. *Id*.
59. *Id*.
60. FOUNDATION, *supra* note 26, at 111.
61. MID-ATLANTIC ASSESSMENT, *supra* note 29, at iv ("Economic analysis suggests that the [Mid-Atlantic Region] *economy* will be resilient to projected climate change.") (emphasis in original). *Id.*
62. *Id*. at iv ("The impacts will make some of the region's citizens and organizations better off while making others worse off, so that the *distribution of impacts* is also an issue.") (emphasis in original). *Id.*
63. *Id*. at iii-iv.
64. *Id*. at iv. *See also id.* at iii (summarizing positive and negative effects, and showing that negative effects greatly outweigh positive effects).

continue over the long term.[65]

B. Making Sense of the Science

Scientific information about climate change is helpful, but it does not necessarily provide a perspective for thinking about climate change or science. We all experience weather–day-to-day changes in temperature, precipitation, cloud cover, and wind. By contrast, climate focuses on average conditions in regions over longer periods, and thus lacks the immediacy of daily changes where we live. Climate change is also different than most other environmental problems. By understanding these differences, and applying some of the same perspectives to climate change that we apply to other environmental problems, we can get a better understanding of the science itself.

To begin with, this is science, not mere opinion. The analytical rigor of the scientific method should be evident to anyone who remembers his or her high school or college science classes. Yet, media reporting on climate change often makes it seem as if scientific opinion is no different than the opinion of editorial writers, sports writers, or the person on the street. Many of the students in my seminars, in fact, seem not to recognize that scientific information is different than other information. If many law students think that way, then surely a significant segment of the general public thinks the same way.

Scientific knowledge is usually developed incrementally, using experiment and observation to test and prove or disprove hypotheses. To ensure that new knowledge is really knowledge and not opinion, scientific norms require a high level of certainty about the accuracy of new information–usually more than 95%.[66] Thus, scientists are expected

65. Under a different set of scenarios, moreover, costs could be very large much sooner. The two models used in these studies both assume gradual warming over the next century and the certain but gradual occurrence of human-induced impacts. But another possibility exists, abrupt climate change. Instead of gradual warming in response to a gradual buildup of greenhouse gases in the atmosphere, average temperatures might suddenly increase or decrease 10 to 20 degrees Fahrenheit, or more, and then stabilize at that level for centuries. Such changes have occurred in history. COMMITTEE ON ABRUPT CLIMATE CHANGE, NATIONAL RESEARCH COUNCIL, ABRUPT CLIMATE CHANGE: INEVITABLE SURPRISES 10, 19-72 (2002) (summarizing historical evidence.). While abrupt future changes could not be ruled out in any case, greenhouse gas emissions by humans make such changes more likely to occur in the future. *Id*. at 107-17, 153-54. Abrupt changes would significantly reduce the ability of humans to adapt. Few environmental or economic studies of the impact of abrupt climate change have been conducted, and there do not appear to be any such studies for Pennsylvania. Still, the negative impacts are likely to be much greater than would occur if the climate changed more slowly. *Id*. at 121, 152.

66. CARL F. CRANOR, REGULATING TOXIC SUBSTANCES 12-48 (Oxford Univ.

to demonstrate that particular information actually supports a stated hypothesis, or that a new theory is supported by new or existing data. One way to ensure the reliability of new information or theories is to subject a draft article or paper to peer review. In fact, peer review is the norm in scientific publications. After submission but before publication, editors of the publication send submitted articles to other experts (peers) in the field for their review and comment. These experts will recommend that the article be accepted, modified, or rejected, and editors will make decisions based in no small part on these peer reviews. After a scientific paper or article is published, other scientists in the field of will examine its evidence and reasoning, attempt to replicate the results, or offer alternative explanations for the conclusions reached in the article. Frequently, these scientists in the field will also prepare articles or papers of their own for publication. And so the process continues.

The IPCC reports and those covering Pennsylvania are based on this scientific process. IPCC assessments are based on peer-reviewed and published literature; IPCC does not conduct its own research or monitoring.[67] The IPCC assessments are also the collaborative work product of hundreds of scientists from developed and developing countries.[68] Both Pennsylvania assessments result from a process that involved peer review, as well as stakeholder participation.[69] While scientific conclusions can change based on new data and observations, these reports represent the best and most authoritative information currently available.

The scale and magnitude of projected climate change effects provides another important perspective. The projected effects from global warming occur at a larger geographic scale, adversely affect more people, and occur over a larger time period than virtually any other environmental problem now being faced. Within Pennsylvania, no individuals, areas, or economic sectors will be unaffected. In 1990, the U.S. Environmental Protection Agency's Science Advisory Board ranked all significant environmental problems according to their risk, and concluded that climate change is one of the four most serious of all environmental problems.[70] By contrast, the Scientific Advisory Board ranked oil spills and ground water pollution as low risk.[71] These

Press; reprint ed. (1992)).

67. *Id*.

68. *See*, e.g., D.L. ALBRITTON ET AL, *supra* note 6, at 24.

69. D.L. ALBRITTON ET AL, *supra* note 6, at 2-4; FOUNDATION, *supra* note 26, at 2.

70. RELATIVE RISK REDUCTION STRATEGIES COMMITTEE, SCIENCE ADVISORY BOARD, REDUCING RISK: SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION 13 (1990). The other high risks are habitat destruction, loss of biodiversity, and stratospheric ozone depletion. *Id*.

71. *Id*.

problems occur in relatively discrete areas and affect relatively few people. The same cannot be said of climate change.

The risk of adverse effects occurring from climate change is also is greater than the risks of other outcomes that would prompt regulation. The United States has a history of acting to protect human health and the environment based on risk (not certainty) of harm. It is inappropriate to treat the risks of increasing greenhouse gases differently than the risks of environmental pollutants.[72] Even when the risks from chemical pollutants are relatively small (for example, a risk of cancer of 1 in 10,000), they are considered serious enough to justify regulation. Here, by contrast, the risk of adverse effects is much greater. The likelihood of higher atmospheric concentrations of carbon dioxide in 2030 and 2085, according to Mid-Atlantic Regional Assessment, is "very high." The likelihood of sea level and temperature increases in and around Pennsylvania is "high," while the likelihood of precipitation increases is "medium."[73] Although the Mid-Atlantic Assessment did not assign numerical probabilities to its confidence levels, the IPCC has described one particular outcome, as "very unlikely," and cited studies stating that there is a 2 to 5% chance that outcome will occur.[74] This particular outcome is the collapse of the West Antarctic Ice Shelf because of human-induced warming; it would result in a six meter (roughly 20 foot) increase in sea levels around the world, inundating many coastal cities.[75] By contrast, the likelihood that a person subjected to a one in 10,000 cancer risk from exposure to a cancer-causing pollutant will actually get cancer is 0.001%. Yet, the collapse of the West Antarctic ice shelf is 200 to 500 times more likely than that. When scientists describe their confidence in a particular outcome as "very high," "high," or even "medium," they are describing outcomes that are either virtually certain or, at a minimum, risks that are far greater than those that would justify regulation of other environmental pollutants.[76]

At a minimum, all of the other effects described above are at least scientifically plausible, and none of these effects is unlikely to occur. There is a reasonable scientific explanation of how global warming could

72. Elliot L. Richardson, *Global Warming and the Risk of Disaster: How Much Do We Care What Happens to the World After We Are Gone?*, LOOKING AHEAD, Jan./Feb. 1999, at 6 (ABA Section of Natural Resources, Energy, and Environmental Law, Chicago, Ill.), (remarks summarizing IPCC findings at section meeting in Hilton Head, South Carolina, Oct. 9, 1998).

73. MID-ATLANTIC ASSESSMENT, *supra* note 30, at 14.

74. J.A. Church & J.M. Gregory, *Changes in Sea Level*, *in* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS 678-79.

75. *Id*.

76. Some of these effects, moreover, are likely to significantly change what it means to live in Pennsylvania. The loss of trout habitat and colorful fall foliage are two examples.

produce each of these outcomes in Pennsylvania. Some of the most potentially damaging effects–such as reduced biodiversity and more severe hurricanes—are also the effects about which there is greatest uncertainty. When there is a plausible scientific basis for a possible effect, the presence of scientific uncertainty about the effect does not justify ignoring that effect.[77]

The precautionary approach or principle provides a useful way of thinking about climate change effects that involve scientific uncertainty. The precautionary approach has been stated in various ways in different international agreements, but the most relevant version is that stated in the Framework Convention on Climate Change. According to the Convention:

> The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaption, and comprise all economic sectors.[78]

The Convention thus suggests a preference or presumption on behalf of measures that are cost-effective, although it does not exclude other measures. It also indicates that cost-effectiveness is most likely to be achieved by a comprehensive approach that applies to sources and sinks, emissions reduction and adaptation, and all economic sectors.

Finally, and most fundamentally, resistance to scientific projections about climate change exists in no small part because the news is negative. The public debate about climate change would be vastly different if the news were primarily positive. The role of psychological denial should not be underestimated.[79] In addition, people tend to couple the negative scientific news with a negative assumption about the legal and policy measures that would be required. Many people seem to feel

77. Donald A. Brown, *The Precautionary Principle as a Guide to Environmental Impact Analysis: Lessons Learned from Global Warming, in* PRECAUTION, ENVIRONMENTAL SCIENCE, AND PREVENTIVE PUBLIC POLICY 141, 152-54 (Joel A. Tickner ed., 2003).

78. Framework Convention, *supra* note 1, *at* art. 3.3. The last sentence of article 3.3, omitted above, states: "Efforts to address climate change may be carried out cooperatively by interested Parties." *Id*.

79. *Cf.* STANLEY COHEN, STATES OF DENIAL: KNOWING ABOUT ATROCITIES AND SUFFERING (2001) (analyzing denial of human rights atrocities).

that, if they admit the validity of the science, they will be forced to accept painful and costly regulation. Because they resist such controls, people deny the validity of the science.

Most of the projected Pennsylvania effects, however, are effects that will likely occur whether Pennsylvania reduces its greenhouse gas emissions or not. Because Pennsylvania can be affected by greenhouse gases emitted anywhere in the world, the most obvious reason for Pennsylvania to act is to protect the state from those effects, or to adapt to them. Moreover, it is not necessarily true that greenhouse gas control measures to address climate change need to be costly or ineffective. Such measures can even result in significant benefits. Development of a state-level climate change strategy would help make the positive role of these measures more clear.

II. Toward A Pennsylvania Strategy

A. Reasons for Action

Pennsylvania needs to adopt and implement a strategy to address climate change for at least five reasons. First, virtually all of the projected impacts fall within the range of the state's police power to protect public health, safety, and welfare.[80] Indeed, most of these impacts concern subjects such as air pollution, forestry, infectious disease, and water supplies for which there are already well-established government programs. It is certainly possible and even likely that the state will be able to adapt many of these changes, but adaptation will involve economic and other costs. These response costs also fall within the state police power.

Second, these impacts also fall within the state constitutional obligation to protect the people's "right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment."[81] As already explained, climate change would likely lead to greater smog, and would significantly change Pennsylvania forests, the range of the Pennsylvania trout population, and other aspects of the environment.[82] The constitution also makes the state a trustee for

80. *See, e.g.*, Commonwealth v. Barnes & Tucker Co., 371 A.2d 461, 465 (Pa. 1977) (quoting Lawton v. Steele, 152 U.S. 133, 137 (1894)); Boundary Drive Assoc. v. Shrewsbury Township Bd of Supervisors, 491 A.2d 86, 90 (Pa. 1985).

81. PA. CONST. art. I, § 27; *see generally*, John C. Dernbach, *Taking the Pennsylvania Constitution Seriously When It Protects the Environment* (pts. I & II), 103 DICK. L. REV. 693 (1999), 104 DICK L. REV. 97 (1999) (detailed analysis of Article I, section 27).

82. See Section I(A).

"Pennsylvania's public natural resources," and requires the state to "conserve and maintain" these resources for the public's benefit.[83] Public natural resources include wild fish and animals as well as surface and groundwater that has not been privately appropriated.[84] The likelihood of climate change impacts on biodiversity and on Pennsylvania waters (from increased precipitation and perhaps other effects) also brings climate change within the scope of the state's public trust responsibilities. In this constitutional sense, too, climate change can be seen as a force that would hinder or interfere with achievement of objectives that the state set years ago, and objectives to which the state is still committed.

Third, Pennsylvania is already responsible for 1% of the world's greenhouse gas emissions.[85] Pennsylvania's greenhouse gas emissions are higher than those of Argentina, the Czech Republic, and more than a hundred other countries.[86] Thus, reductions in greenhouse gases by Pennsylvania are significant in their own right.

Fourth, actions to adapt to climate change and to reduce greenhouse gas emissions would also provide the state with significant economic and other opportunities. States that have already begun to address climate change have been able to reduce other air pollutants, foster the development of new technologies, create jobs, grow businesses, reduce the effect of fossil fuel price fluctuations on the poor, reduce energy costs for residences and businesses, and achieve other benefits.[87] These benefits are experienced at the state or regional level, where the laws or

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83. PA. CONST. art. I, § 27.

84. Dernbach, *supra* note 81, at 120-22.

85. In 1990, Pennsylvania emissions were estimated at 79.3 million tons of carbon equivalent. *See* U.S. Envtl. Prot. Agency, Pennsylvania Greenhouse Gas Emissions and Sinks Inventory: Summary (1990), *available at* http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/JSIN5DQT4K/$file/PASummary_v2.PDF. In 1990, global emissions were between 6,900 and 8,400 million metric tons of carbon equivalent. William R. Moomaw & Jose Roberto Moreira, *Technological and Economic Potential of Greenhouse Gas Emissions Reduction, in* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: MITIGATION at 264 (Bert Metz et al. eds. 2001). If we multiply 79.3 million tons by 100, we get 7,930 million tons, which is between the 6,900 and 8,400 million ton total for global emissions. Thus, Pennsylvania's emissions are roughly 1% of global emissions.

86. Gregg Marland and Tom Boden, National CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-1999 (2002), *available at* http://cdiac.esd.ornl.gov/ftp/ndp030/nation99.ems. If Pennsylvania were a country, however, it would not be among the top 20 emitters. *Id.*

87. Barry G. Rabe, *Greenhouse and Statehouse: The Evolving State Government Role in Climate Change*, *available at* http://www.pewclimate.org/projects/states_greenhouse.pdf; John Dernbach and the Widener University Law School Seminar on Global Warming, *Moving the Climate Debate from Models to Proposed Legislation: Lessons from State Experience*, 30 ENVTL. L. REP. (Envtl. L. Inst.) 10933, 10974-75 (2000).

policies have been put in place. Greenhouse gas emission reductions, by contrast, reduce projected concentrations of greenhouse gas emissions in the atmosphere, but do not achieve a greater climate change benefit for the state that required or encouraged them. Somewhat ironically, then, one of the most important reasons for states to reduce greenhouse gas emissions is to achieve ancillary or other benefits. These benefits have been a primary motivation for states that have already done so.[88] Because pressure to reduce greenhouse gases and adapt to climate change is likely to increase rather than decrease over time, some of these benefits are likely to have growing economic value. States that incubate energy conservation, energy efficiency, and renewable energy businesses, for example, and the technology and know-how that comes with them, are likely to experience considerable economic benefits as market demand for these things grow.

In at least one respect, Pennsylvania is already experiencing these economic opportunities. The state's partial deregulation of electric utilities[89] has permitted customers to choose their own electricity provider. Because customers are no longer required to purchase electricity from the local utility, they can choose to purchase electricity from providers that rely more on renewable energy. As a result, the state is seeing small but steady growth in the use of wind power to provide electricity, and thus growth in the wind power industry. This legislation was not intended to reduce Pennsylvania's emissions of greenhouse gases. It was intended, rather, to foster customer choice and reduced prices for electricity.

Fifth, climate change is not an issue for which Pennsylvania can count on the national government for meaningful action. President George W. Bush's decision not to participate in the Kyoto Protocol was followed by announcements of various voluntary programs.[90] Some federal legislation exists that directly addresses climate change, including authorization for a national registry of voluntary greenhouse gas emissions[91] and recently enacted legislation that authorizes studies of carbon sequestration.[92] There is also an array of energy related laws that

88. Rabe, *supra* note ,87 at 9-10; Dernbach et al., *supra* note 87, at 10974.

89. 66 PA. C.S.A. §§ 2801-2812 (1999).

90. See John Dernbach et al., *Climate Change and Sustainable Development: 2001 Annual Report*, *in* ENV'T, ENERGY, AND RESOURCES L.: THE YEAR IN REVIEW 220, 224 (2002).

91. Energy Policy Act of 1992 §1605(b); 42 U.S.C. § 13385(b) (1992).

92. 7 U.S.C. § 6711 (2000) (authorizing grants and cooperative research for studies of soil carbon research and the carbon cycle); *see also* 16 U.S.C. § 2103 (1978) (establishing forest land enhancement program for the purpose, among others, of "[i]ncreasing and enhancing carbon sequestration opportunities"). *Id*. § 2103(b)(5).

have been enacted over the last several decades.[93] But there is little executive or legislative effort on the horizon to achieve significant reductions in greenhouse gas emissions or adapt to climate change.[94] As a result, the primary opportunities that Pennsylvania has to address this issue are those that it creates for itself.

This is not to deny the attractiveness of a serious national effort. But waiting for that effort makes little sense given the problems that Pennsylvania will need to address. Indeed, it can be argued that the experience of Pennsylvania and other states in addressing climate change will make federal legislation more likely. The experience and knowledge that Pennsylvania gains will provide a more realistic basis for understanding the effects of a serious national effort to address climate change. It is also possible that conflicting or inconsistent state laws would prompt national legislation to achieve consistency.[95]

B. A Comprehensive Approach

The most attractive approach, as the precautionary language in the Framework Convention on Climate Change suggests, would consider all relevant greenhouse gases, all sources and sinks, and all economic sectors. The language also suggests consideration of measures required for adaptation and measures required to reduce greenhouse gas emissions. This approach is more likely to be effective, more likely to maximize benefits, and more likely to reduce costs.

A variety of gases can contribute to climate change. The six gases subject to control under the Kyoto Protocol are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.[96] Carbon dioxide is the most commonly discussed greenhouse gas and makes the largest contribution to climate change, but it is not the most potent greenhouse gas. The other gases are emitted in smaller amounts but have, on a ton-for-ton basis, more global warming potential than carbon dioxide. Over a 100-year time horizon, for instance, one ton of nitrous oxide has 296 times the global warming potential of a ton of carbon dioxide, and a ton of methane has 23 times

93. *See generally*, Alan S. Miller, *Energy Policy from Nixon to Clinton: From Grand Provider to Market Facilitator*, 25 ENVTL. L. 715 (1995).

94. Recently introduced legislation includes S. 139, 108th Cong. (2003) (proposed Climate Stewardship Act of 2003, which is intended to provide a comprehensive framework for greenhouse gas emission reductions) and S. 194, 108th Cong. (2003) (which would establish an inventory and information system for U.S. greenhouse emissions).

95. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 87, at 10977-79.

96. Kyoto Protocol, *supra* note 4, Annex A.

the global warming potential of a ton of carbon dioxide.[97] Pennsylvania's operating and abandoned underground coal mines are a significant source of methane emissions. An effort that focused only on carbon dioxide would not be as effective as an effort that focused on all relevant gases. A focus on all gases, moreover, provides more opportunities to create opportunities (including opportunities for the coal industry) and reduce costs.

In addition, it is necessary to consider both sources and sinks. Sources are activities or processes that release greenhouse gas emissions into the atmosphere; sinks remove greenhouse gases from the atmosphere.[98] Forests are sinks because they absorb and store carbon dioxide. The object is to reduce *net* emissions (total emissions less the amount absorbed by sinks). While the effectiveness of carbon sequestration or storage is not settled, it would likely help reduce costs and increase the benefits of addressing climate change.

Adaptation also needs to be incorporated into any state approach. Because warming has already begun to occur and is almost certain to increase in coming decades, adaptation cannot be ignored. Adaptation is also a necessary response to the failure of the international community, including the United States, to prevent the continuing increase of greenhouse gases in the atmosphere. Whatever the sources of these growing greenhouse gas concentrations, their effect will be felt in Pennsylvania (among other places).

All economic sectors that contribute to greenhouse gas emissions need to be considered. Transportation, electricity generation, manufacturing, residential heating and air conditioning, and commercial heating and air conditioning are all sources of greenhouse gas emissions. It is thus appropriate to address all of these sources. Moreover, it is difficult to think of economic sectors that will not be affected by climate change in Pennsylvania. Forestry and agriculture would be directly affected, for instance, and other economic sectors will experience indirect effects. The likelihood of adaptation for many economic sectors does not mean that adaptation will be cost free. In that respect, too, all economic sectors need to be considered.

C. Available Tools

Any climate change law or policy would need to achieve at least one of the following: 1) reduction in greenhouse gas emissions; or 2) sequestration of carbon dioxide; or 3) adaptation to climate change.

97. V. RAMASWAMY ET AL, *supra* note 13, at 388.
98. Framework Convention, *supra* note 1, at arts. I(8) and I(9).

These goals need not and should not, however, be the only goals. Other goals should include achievement of economic benefits, reduction in pollutants other than greenhouses, social equity, cost reduction, job creation, technological innovation, and economic development.[99]

Dozens and even hundreds of legal and policy tools are available to states to address climate change in these ways.[100] While some of these laws and policies may have broad application, many are specific to particular economic sectors, such as agriculture, forestry, and waste management.[101] Indeed, the range of economic sectors is one reason for the large number of available tools. It is, of course, possible to adopt new laws. But much of the required law and policy making needs to occur in areas where laws already exist. Some existing laws and policies can be modified, and used as a foundation for, programs to address greenhouse gas emissions. In other cases, laws and policies may encourage activities that increase greenhouse gas emissions, or may make people and businesses more rather than less vulnerable to climate change. In those cases, it may be more appropriate repeal or rewrite existing laws and policies.

Taxation of greenhouse gas emissions and emissions trading are the most commonly mentioned tools.[102] These tools could have broad applicability. The idea behind a tax is to reduce greenhouse gas emissions by increasing their cost. Increased tax revenues could be used to offset tax reductions elsewhere, or they could be used for other purposes. Emissions trading is a shorthand way of referring to a variety of different schemes that include trading. The most effective form of this system begins with an overall cap or limit on emissions that is to be achieved at a specific future date. That cap is then converted into a cap on each source subject to the overall cap. It is likely that the costs of emissions reduction at each of these sources will vary. If Sources A and

99. Potential criteria could cover a much broader scope. They could include "environmental effectiveness, cost effectiveness, distribution considerations, administrative and political feasibility, government revenues, wider economic effects, wider environmental effects, and effects on changes in attitudes, awareness, learning, innovation, technological progress, and dissemination of technology." Igor Bashmakov & Catrinus Jepma, *Policies, Measures, and Instruments*, CLIMATE CHANGE 2001: MITIGATION at 401, *see* Moomaw & Moreira, *supra* note 86.

100. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 88, at 10951.

101. Rabe, *supra* note 88, at 18-21 (agriculture), 21-23 (forestry), & 23-25 (waste management).

102. Igor Bashmakov & Catrinus Jepma, *Policies, Measures, and Instruments*, *in* CLIMATE CHANGE 2001: MITIGATION, *supra* note 100, at 413-17 (summarizing literature on taxes and trading); John Dernbach and the Widener University Law School Seminar on Global Warming, supra note 87, at 10941-46 (explaining these tools in greater detail and their use in models concerning the likely effect of climate change legislation on the United States).

B, which now emit 100 tons of carbon dioxide per year, are obliged to reduce their emissions to 90 tons per year in five years, it may cost $50 per ton for Source A and $10 per ton for Source B. If Source A and Source B were forced to meet these caps separately, the total cost would be $600 ($500 for Source A and $100 for Source B). But Source B could reduce its emissions by 20 tons by the specified year for $200, even if Source A did nothing. Trading allows Source B to sell its excess reductions to Source A, and, thus, gives Source A a less expensive way to meet its cap than achieving this reduction by itself.

While taxes and trading are economically attractive, they are not the only available legal tools. Carbon taxes, moreover, may not be politically acceptable. Government action is more likely to be effective when several legal or policy measures are employed at the same time. Sometimes, government action is most effective when taxes or trading are combined with these other instruments. Among states that have been active in this area, in fact, no particular legal or policy tool predominates over others.[103] What follows is an illustrative list of legal and policy tools from which Pennsylvania could draw.

Adaptation Measures. Many measures would make Pennsylvania more resilient to climate change and provide economic benefits "even if climate stays the same." These win-win adaptation measures include removal of incentives that put people and businesses at greater risk of flooding and improvement of watershed management to reduce flood damage and protect water quality.[104] The state could also improve monitoring for climate-related diseases, foster forestry practices that encourage planting tree species that are likely to become dominant, improve protection of public water supplies from droughts and flooding, encourage greater use of water conservation, and help foster agricultural adaption to changed climate.[105] Other important adaptation strategies include early warning systems, as well as greater use of air conditioning and other means to reduce heat-related deaths and sickness.[106]

Electricity Generation. As previously noted, Pennsylvania has already permitted customers to choose their own electricity provider–a move that is increasing the amount of renewable electricity generated in the state. Many other legal and policy options are also available. The state could require electricity providers to disclose, in their bills to customers and in other information, their energy sources (e.g., 60% coal, 35% nuclear, 5% wind). This disclosure would enable customers to

103. Rabe, *supra* note 87, at 40.
104. MID-ATLANTIC ASSESSMENT, *supra* note 29, at 42.
105. *Id*.
106. FOUNDATION, *supra* note 26, at 129.

make a more informed choice about their electricity providers.[107] A renewable energy portfolio standard would increase the percentage of electricity generated in Pennsylvania. Such standards are ordinarily established in steps, increasing by 1 to 2% within several years, and then increasing again by 1 to 2% several years later. This goal might then be imposed on each of the electric utilities operating in Pennsylvania. To reduce costs, some states permit utilities to exceed the requirement for renewable electricity and then sell (or trade) their "excess" renewable energy to other utilities.[108] Another possibility is for legislators to use tax credits to encourage homeowners and businesses to generate electricity through renewable energy, or to reduce their use of electricity.[109] Still another possibility, known as net metering, is to permit homeowners and businesses who generate their own renewable energy to sell their excess electricity to the local utility.[110] Together, net metering and a tax credit for the use of renewable energy provide a stronger incentive than either tool alone. Tools that increase the use of renewable energy, such as these, prevent increases in greenhouse gas emissions or reduce these emissions.

Some states have imposed direct controls on carbon dioxide emissions from electric generating plants.[111] While sulfur dioxide, nitrogen oxides, and certain other pollutants are regulated under the federal Clean Air Act[112] and related state laws, carbon dioxide is not. Thus, another option is to modify Pennsylvania's air pollution control laws to include carbon dioxide emissions.

Residential and Commercial Energy. When homes and businesses do not use electricity for heating and air conditioning, they are probably using oil or natural gas. Thus, residential and commercial energy use is not necessarily included within electrical generation. Properly designed, buildings can use much less energy. Insulated walls and double-pane windows are two common examples. Such approaches may involve higher up front materials and design costs, even if they save money over

107. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 87, at 10956-58.

108. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 87, at 10962-64; Rabe, *supra* note 87, at 12-15.

109. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 87, at 10971-72.

110. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 87, at 10958-60*; see also* Valerie J. Faden, *Net Metering of Renewable Energy: How Traditional Electricity Suppliers Fight to Keep You in the Dark*, 10 WIDENER J. PUB. L. 109 (2000) (assessing the ways utilities inhibit the use of net metering).

111. Rabe, *supra* note 87, at 16-18 (describing Massachusetts and New Hampshire programs).

112. 42 U.S.C. §§ 7401-7671(q) (2003).

the long term. The state has already taken some leadership on this issue by designing and operating some state buildings in an extremely energy-efficient manner. The state could broaden this to a greater number of, and eventually to all, new state buildings. Another choice is energy efficiency provisions in building codes, which can cut the use of energy, reducing energy costs for residences and businesses, providing some financial relief for the poor, and permitting businesses to spend some of their money in other ways.[113]

Industry. Some states have adopted their own greenhouse gas registries, modeled on the federal registry, ensuring that companies that act earlier to reduce their greenhouse gas emissions will get credit for these reductions, even though they occur before any regulatory program is created.[114] Usually, regulatory programs require reductions from a baseline level of emissions that coincides with enactment of the programs. Thus, if Company X and Company Z, similarly situated and competitors, both emit 100,000 tons of carbon dioxide per year in the year when controls are put in place, both might be required to reduce their emissions 10%, to 90,000 tons. Company X may be capable of voluntarily reducing its emissions by 15%, to 85,000 tons, before any legislation is passed. To encourage Company X to do that, though, Company X must be given some assurance that its early reductions will not be deemed irrelevant when controls are adopted. Otherwise, when controls are put in place, it might be required to reduce its emissions by 8,500 *additional* tons (10% of its current emission levels), to 76,500 tons. In addition to penalizing Company X, such a result might also give a competitive advantage to Company Z. State registries can help ensure that Company X will get credit for its early reductions when any controls are adopted, and, thus, help encourage early reductions.

Another option of course is to apply emissions limitations to the atmospheric release of carbon dioxide and other greenhouse gases. Some states have begun to do that for electric utilities, but such measures could also be applied to industry. Such controls should, of course, give credit to properly documented early reductions. Any such controls should also provide opportunities for emissions trading.

Transportation. The federal government's extensive regulation of air emissions from motor vehicles under the Clean Air Act makes it difficult if not impossible for states to directly regulate carbon dioxide emissions from cars. In 2002, California adopted legislation directing the California Air Resources Board to set standards for carbon dioxide

113. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 87, at 10,964-65.

114. Rabe, *supra* note 87, at 33-36 (describing Wisconsin program).

emissions from motor vehicles.[115] Because of its historic leadership position in limiting automobile emissions, however, the federal Clean Air Act allows California to set its own standards.[116] If the state is able to set these standards and successfully defend the law in the courts, it might be possible for Pennsylvania and other states to adopt California's approach as their own. Otherwise, Pennsylvania's choices mostly involve ways of reducing motor vehicle use. Options include modifications in land use laws to encourage more compact communities and greater variety of permitted land uses within a community; greater financial support for mass transit; use of hybrid or alternative fuel vehicles in the state fleet; and greater use of ethanol (made from corn) as a vehicle fuel. Another set of possible options is based on public information linking air quality to congested traffic, voluntary initiatives, and ride-sharing programs.[117]

Technological Innovation and Diffusion. For all economic sectors, a major challenge is the absence of widely available and cost-effective alternative technologies that do not produce greenhouse gas emissions. Hence, a necessary component of any effort to reduce greenhouse gas emissions is comprehensive and adequately funded government research and development.[118] Pennsylvania could contribute directly to such research and development, or it could foster economic development programs targeting particular industries (e.g., wind, deep carbon storage, energy conservation) that attract private capital through the sale of goods and services, and which then apply part of that capital to their own research and development. This is simply conventional economic development, with all of the various tools that Pennsylvania has traditionally used, but applied in the climate change context.[119] Alternatively, regulatory programs may foster improvements in technology.[120]

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115. *See* Assembly Bill No. 1493 *available at* http://info.sen.ca.gov/pub/01-02/bill/asm/ab_1451-1500/ab_1493_bill_20020722_chaptered.pdf at 2 (last visited Jan. 16, 2003).

116. 42 U.S.C. § 7543(b) (2003).

117. Rabe, *supra* note 87, at 26-29 (describing transportation program for Atlanta metropolitan area).

118. Martin I. Hoffert et al., *Advance Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet*, 298 SCIENCE 981 (2002).

119. *See* David Osborne, LABORATORIES OF DEMOCRACY: A NEW BREED OF GOVERNOR CREATES MODELS FOR NATIONAL GROWTH 43-81 (1999) (describing various economic development programs in Pennsylvania under former governor Dick Thornburgh, including the Ben Franklin Partnership for commercializing academic research).

120. *See* Igor Bashmakov & Catrinus Jepma, *Policies, Measures, and Instruments*, *in* CLIMATE CHANGE 2001: MITIGATION, *supra* note 100, at 441-43 (assessing the effects of different laws and policies on technological innovation).

Carbon Sequestration. Carbon can be stored in soil through soil conservation programs and farming practices such as no-till agriculture that leave the soil undisturbed.[121] Thus, government programs that encourage such practices can also be an important tool to address climate change. Limits on the atmospheric release of carbon dioxide can also be structured to permit or require carbon sequestration. Such limits could be enforced by imposing direct reductions on particular types of facilities, requiring such facilities to sequester specified amounts of carbon, or both.[122]

D. A Strategic Approach

Given the need to address this issue comprehensively, and the variety of available legal choices, how should Pennsylvania proceed? The short answer is to develop and implement a strategy. About half of the states have developed such strategies or action plans.[123]

The first step in preparing a strategy to reduce greenhouse gas emissions is to prepare an inventory of existing greenhouse gas emissions. An inventory allows policy makers to both benchmark emissions and to understand the major sources of emissions within a jurisdiction. The typical greenhouse gas inventory identifies total emissions from the transportation, electric utility, industrial, and commercial and residential sectors. Almost two-thirds of the states have developed greenhouse gas emission inventories.[124] Such an inventory was prepared for 1990 emissions, but it has not been updated. An updated inventory has recently been completed for Pennsylvania by the Pennsylvania Consortium for Interdisciplinary Environmental Policy (PCIEP), an organization of 42 Pennsylvania colleges and universities funded by the Departments of Environmental Protection and Conservation and Natural Resources. A preliminary step is to evaluate that inventory.

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121. John Dernbach and the Widener University Law School Seminar on Global Warming, *supra* note 87, at 10970-71.

122. *Id.* (describing Oregon program that works in this manner).

123. U.S. Environmental Protection Agency, Action Plans, *available at* http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ActionsStateActionPlans.html?OpenDocument. (last visited Oct. 15, 2003)*; see also* U.S. Environmental Protection Agency, States Guidance Document: Policy Planning To Reduce Greenhouse Gas Emissions, Second Edition (1998), *available at* http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ResourceCenterPublicationsReferenceStateGuidanceDocument.html (last visited Oct. 15, 2003).

124. U.S. Environmental Protection Agency, State Emissions, *available at* http://yosemite.epa.gov/globalwarming/ghg.nsf/emissions/state (last visited Oct. 15, 2003).

A second necessary step is to educate Pennsylvania residents about the effects and opportunities provided by climate change. A state-level clearinghouse on the economic opportunities created by global warming would be very helpful. Because there is likely to be greater support for global warming policies in Pennsylvania if Pennsylvanians better understood global warming issues, the state should support greater public education, both in the schools and in public information.

The state's strategy should be developed in the context of this revised emissions inventory and public education program. The strategy should be developed in the context of an intense public participatory process. It should result, at some point, in the setting of a goal to achieve a certain reduction of net greenhouse gas emissions within a certain time. Specific adaptation goals may also be appropriate.[125] The strategy should include a set of proposed administrative, legislative, and voluntary measures to meet these goals.[126] The strategy should also include support and encouragement for local government efforts to address climate change. In addition, the strategy should be accompanied by some kind of administrative mechanism to oversee its development and implementation. Creation of a state-level scientific advisory board on climate change may be a useful part of the state's educational and policy development effort.

This kind of strategic process has several advantages. It provides a broad look at the available choices, and should result in a menu of measures that will achieve significant results, that will be cost effective, and that will be politically acceptable. It should also provide a means of determining priorities. A particular advantage of a strategic approach is that it should avoid over reliance on any one part of the problem, any one economic sector, or any one legal or policy measure.

This type of strategic process should also put other important questions in front of Pennsylvania decision makers. Two are illustrative. The Conference of New England Governors and Eastern Canadian Premiers, which includes six U.S. states and five Canadian provinces, has adopted a Climate Change Action Plan that includes a regional emissions registry and regional emission reduction goals.[127] As interest

125. Because some individuals and economic sectors will be affected more than others, the strategy should identify the affected individuals and economic sectors and identify how they are likely to be affected.

126. Four relevant bills were introduced in 2001 in the Pennsylvania General Assembly. These bills are: H.B. 1076, the Personal Power Enabling Act; H.B. 1077, the Green Buildings Act; H.B. 1078, the Wind Energy Enterprise Act; and H.B. 1079, the Renewable Energy Procurement Act.

127. The New England Governors and the Eastern Canadian Primiers, Resolution 27-7 (resolution concerning climate change) (2002), *available at* http://www.negc.org/02En003.html (last visited Oct. 15, 2003) *see also*

in this regional approach grows, it may be appropriate for Pennsylvania to consider joining these states and provinces. In addition, although the United States has decided not to join the Kyoto Protocol, a possibility exists that the United States may at some future point want to rejoin the Kyoto process. After all, the United States is still a party to the Framework Convention on Climate Change. It may thus be in Pennsylvania's benefit, where appropriate, to use terms and procedures that are consistent with those in the Kyoto Protocol.[128]

III. Conclusion

Climate change provides both great risks and great opportunities for Pennsylvania. A key to taking advantage of the opportunities is to recognize the importance of the laws and policies that are put in place or modified. Other states have used laws and policies to realize a variety of economic, social, and even environmental benefits, wholly apart from their greenhouse gas reduction benefit. Pennsylvania can and should do the same.

THE NEW ENGLAND GOVERINORS AND THE EASTERN CANADIAN PRIMIERS, REPORT TO NEW ENGLAND GOVERNORS AND EASTERN CANADIAN PRIMIERS ON CLIMATE CHANGE PROJECTS (2002), *available at* http://www.negc.org/documents/850088026.pdf (summarizing accomplishments of regional effort on climate change) (last visited Oct. 15, 2003).

128. David J. Hayes & Nicholas Gertler, *The Role of Carbon Sequestration in the U.S. Response to Climate Change–Challenges and Opportunities*, 32 ENVTL. L. REP. (Envtl. L. Inst.) 11350, 11354-55 (2002) (arguing that the United States should minimize divergences between its approach and that taken under Kyoto Protocol).