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Global Warming: A Comprehensive Approach

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I. INTRODUCTION

The nations of the world are engaged in drawing up a framework treaty dealing with climatic change, scheduled to be signed at the "earth summit" in June 1992.[1] Many prominent industrialized nations, acting upon the recommendation of the Intergovernmental Panel on Climate Change (IPCC),[2] are willing to stabilize carbon dioxide (CO_2) emissions at 1990 levels by the year 2000.[3] Other nations are even willing to undertake subsequent reductions of up to twenty or thirty percent.[4] On the other hand, the United States resists significant reductions of CO_2 emissions and leads opposition to any treaty regime attempting to set timetables for such reductions.[5] The United States instead advocates a "comprehensive

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1. *See* G.A. Res. 212, U.N. GAOR, 45th Sess., Supp. No. 49A, at 148, U.N. Doc. A/45/49 (1990) (establishing an Intergovernmental Negotiating Committee to draft an "effective" framework convention, and designating the U.N. Conference on Environment and Development (UNCED), to be held in Rio de Janeiro in June 1992, as the venue for signing the convention).

2. The IPCC was established in 1988 by the World Meteorological Organization and United Nations Environment Programme to assess the scientific information related to the various components of climatic change, and to formulate realistic response strategies. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT (J.T. Houghton et al. eds., 1990) [hereinafter IPCC SCIENTIFIC ASSESSMENT].

3. These countries include Australia, Belgium, Canada, the European Community countries, the European Free Trade Agreement, Japan, New Zealand, the Netherlands and the United Kingdom. *Unilateral Efforts to Reduce Greenhouse Gases*, 14 Int'l Env't Rep. (BNA) 120 (Feb. 27, 1991).

4. These countries include Australia, Austria, Denmark, Germany, Italy, Luxembourg, the Netherlands, New Zealand, and Norway. *Id.*

5. The United States consistently has refused to agree to specific limits or timetables. The most recent refusal was expressed at the formal negotiations within the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change at Nairobi, September 9-10, 1991. *See Money, U.S. Position Remain Barriers for Accord on Climate Change Issues*, 14 Int'l Env't Rep. (BNA) 502 (Sept. 25, 1991); *see also At Meeting on Global Warming, U.S. Stands Alone*, N.Y. TIMES, Sept. 10, 1991, at B5. This was preceded by similar positions within the Intergovernmental Panel on Climate Change (IPCC), and at numerous conferences. Some of these were: the Toronto Conference, June 1988; the Hague Conference, March 1989; The G-7 Summit, July 1989; the Noordwijk Ministerial Conference, November 1989; the Bergen Ministerial Meeting, May 1990. For a useful summary of these meetings, and the declarations they made, see David A. Wirth & Daniel A. Lashof, *Beyond Vienna and Montreal—Multilateral Agreements on Greenhouse Gases*, *in* GREENHOUSE WARMING:

approach" (USCA) to global warming that will consider all major greenhouse gases (GHGs) that are responsible for climatic change, such as methane, nitrous oxides, and chlorofluorocarbons, as well as CO_2. Such a policy would enable the United States to respond flexibly by committing to decreases in the emissions of any combination of these gases in order that total global warming potential (GWP) be stabilized or reduced.[6]

The United States bases its arguments on the fact that the main GHGs implicated in global warming have different atmospheric lifetimes and "radiative forcing" (or global warming capacity). According to the U.S. position, although CO_2 emissions constitute over fifty percent of anthropogenic (man-made) emissions, the other GHGs possess a higher radiative forcing capacity, and their concentrations are growing more rapidly than CO_2. Consequently, "the relative contribution of CO_2 to total atmospheric radiative forcing has declined since 1880 and may decline further in the future."[7] Thus, pointing to the importance of the combined GWP of all GHGs, and implying that this fact has been overlooked by the IPCC and other industrial countries, the United States calls for a comprehensive approach that deals with all of these gases in the round and allows for flexible responses.[8]

Notwithstanding its advocacy of a comprehensive approach, U.S. objections to binding timetables for reducing CO_2 emissions apply equally to its proclaimed objective of reducing all GHGs. This is because although CO_2 reductions must be a component of any comprehensive package, the United States resolutely refuses to set timetables for such reductions. As a result, the U.S. professed objective of halting global warming becomes functionally unattainable, and reduces the so-called comprehensive approach to a cipher. The goal is relegated to remaining aspirational, with no possibility of being realized, and the legal obligations are rendered

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NEGOTIATING A GLOBAL REGIME 13, 16-18 (Jessica T. Mathews ed., 1991).

6. *See generally* NATIONAL ENERGY STRATEGY 172-84 (1st ed. 1991-92); AMERICA'S CLIMATE CHANGE STRATEGY: AN ACTION AGENDA (1991) (statement of U.S. policy) [hereinafter AMERICA'S CLIMATE CHANGE STRATEGY]; Richard B. Stewart & Jonathan B. Wiener, *A Comprehensive Approach to Climate Change*, AM. ENTERPRISE, Nov.-Dec. 1990, at 75; U.S. DEP'T OF ENERGY, THE ECONOMICS OF LONG-TERM GLOBAL CLIMATE CHANGE (Sept. 1990).

7. U.S. DEP'T OF STATE, A "COMPREHENSIVE" APPROACH TO ADDRESSING POTENTIAL GLOBAL CLIMATE CHANGE 5 (Feb. 3, 1990) [hereinafter Global Climate Seminar] (discussion paper from seminar on U.S. experience with "Comprehensive" and "Emissions Trading" approaches to environmental policy).

8. The National Energy Strategy stresses "flexibility" as a major facet of the U.S. Comprehensive Approach. *See infra* text accompanying note 32.

meaningless. This article first will argue that as a political objective the reluctance of the United States to enter into legal obligations regarding CO_2 emissions robs the USCA of its strength and effectiveness. U.S. resistance to binding obligations casts serious doubts on its commitment to arrest global warming.

An "approach" to a problem is not an end unto itself but merely a means to an end. It is a procedure or technique for solving a problem. Halting the advance of global warming and providing a means for doing so must remain the final objectives of any international treaty regime. Even though the National Energy Strategy (NES) and other official U.S. declarations proclaim the objective of arresting global warming,[9] they do so for mixed reasons. What they espouse is a "no regrets" policy under which any action taken to abate global warming should be wholly justified on other grounds. The explanation for reducing chlorofluorocarbons (CFCs) or nitrous oxides, for example, is that their reduction is required under the Montreal Protocol[10] or the Clean Air Act Amendments of 1990.[11] In the end, USCA is a confusing and tangled weave between a political holding action and a cheap insurance policy, covering only rosy global warming scenarios.

Secondly, this article will show that as an environmental strategy, USCA fails on its own terms. Global warming is a problem of energy pollution; thus a truly comprehensive or integrated approach must be a synoptic or holistic one that attempts to deal with energy pollution in its totality. It must encompass the whole web of pollution including its impacts as well as its socioeconomic sources and implications.[12] Like the USCA,

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9. NATIONAL ENERGY STRATEGY, *supra* note 6, at 172-85; AMERICA'S CLIMATE CHANGE STRATEGY, *supra* note 6.

10. Montreal Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987, S. TREATY DOC. NO. 10, 100th Cong., 1st Sess. (1987), *reprinted in* 26 I.L.M. 1550 (1987), *amended and adjusted* S. TREATY DOC. NO. 4, 102d Cong., 1st Sess. (1991), *reprinted in* 30 I.L.M. 537 (1991) [hereinafter Montreal Protocol].

11. Clean Air Act Amendments of 1990, Pub. L. No. 101-549, § 101, 104 Stat. 2399 (1990).

12. Integrated Environmental Control (IEC) is synonymous with a comprehensive approach. Integrated Environmental Control and Integrated Pollution Control, the progenitor of Integrated Environmental Control, are discussed in CONSERVATION FOUND., CONTROLLING CROSS-MEDIA POLLUTANTS (1984); CONSERVATION FOUND., THE ENVIRONMENTAL PROTECTION ACT: SECOND DRAFT (1988) [hereinafter CONSERVATION FOUND., ENVIRONMENTAL PROTECTION ACT]; CONSERVATION FOUND., INTEGRATED POLLUTION CONTROL IN EUROPE AND NORTH AMERICA (Nigel Haigh & Frances Irwin eds., 1990); CONSERVATION FOUND., NEW PERSPECTIVES ON POLLUTION CONTROL:

a true comprehensive approach starts with the principle that we should deal with the impacts of all, not just one of the GHGs. But, unlike the misnamed U.S. version, a true comprehensive approach (TCA) does not stop there. Instead, it pursues the GHGs to their sources within the web of energy policy and decision-making. A TCA thus logically will question the dependence on fossil fuels responsible for generating GHGs. The USCA categorically refuses to do this. In fact, it reproaches any energy policies that call for the pursuit of CO_2 emissions to their sources as "carbocentric" thinking.[13] By adopting such a position, the USCA renders itself incomprehensible. Exasperatingly, the United States, like Janus, faces both ways. It professes a comprehensive approach, yet simultaneously rejects vital and fundamental principles of such an approach.

Finally, this article will argue for a TCA that successfully can halt global warming. A TCA reveals the full social and economic costs of fossil fuel dependence and canvases the possibilities of alternative fuels. A TCA will demonstrate that the objective of reducing CO_2 possesses both economic and environmental virtues. In the end, the adoption of a TCA will

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CROSS-MEDIA PROBLEMS (1985); CONSERVATION FOUND., STATE OF THE ENVIRONMENT: AN ASSESSMENT AT MID-DECADE (1984) [hereinafter CONSERVATION FOUND., STATE OF THE ENVIRONMENT]; BARRY G. RABE, FRAGMENTATION AND INTEGRATION IN STATE ENVIRONMENTAL MANAGEMENT (1986); Lakshman D. Guruswamy, *The Case for Integrated Pollution Control*, 54 LAW & CONTEMP. PROBS. 41 (1991); Lakshman D. Guruswamy, *Integrated Environmental Control: The Expanding Matrix*, 22 ENVTL. L. 77 (1992); Lakshman D. Guruswamy, *Integrated Pollution Control: The Way Forward*, 7 ARIZ. J. INT'L & COMP. L. 173 (1990); Lakshman D. Guruswamy, *Integrating Thoughtways: Re-Opening of the Environmental Mind*, 3 WIS. L. REV. 463 (1989). *See generally Integrated Pollution Control: A Symposium* 22 ENVTL. L. 1 (1992).

The National Research Council and National Academy of Public Administration, after studying the subject, have lent their weighty support toward the adoption of an integrated approach to pollution control. *See* NAT'L ACAD. OF PUB. ADMIN., STEPS TOWARD A STABLE FUTURE (1984); NAT'L RES. COUNCIL, MULTIMEDIA APPROACHES TO POLLUTION CONTROL: A SYMPOSIUM PROCEEDINGS (1987).

In the United Kingdom the Royal Commission on Environmental Pollution (RCEP) has taken the lead in advocating an integrated approach. *See* ROYAL COMM'N ON ENVTL. POLLUTION, FIFTH REPORT: AIR POLLUTION CONTROL AN INTEGRATED APPROACH (1976); ROYAL COMM'N ON ENVTL. POLLUTION, TENTH REPORT: TACKLING POLLUTION-EXPERIENCES AND PROSPECTS (1984) [hereinafter RCEP TENTH REPORT]; ROYAL COMM'N ON ENVTL. POLLUTION, ELEVENTH REPORT: MANAGING WASTE: THE DUTY OF CARE (1985); ROYAL COMM'N ON ENVTL. POLLUTION, TWELFTH REPORT: BEST PRACTICABLE ENVIRONMENTAL OPTION (1988); *see also* DEP'T OF THE ENV'T, UNITED KINGDOM WELSH OFFICE, INTEGRATED POLLUTION CONTROL: A CONSULTATION PAPER (July 1988).

13. Stewart & Wiener, *supra* note 6, at 3.

enable the United States—the undisputed world leader—to build an effective treaty regime for global warming.

II. OBJECTIVES OF THE U.S. COMPREHENSIVE APPROACH

The United States now accepts that something is seriously wrong with the atmosphere—our global commons. Approximately six billion tons of carbon are added to the atmosphere each year. CO_2 is the most important of the trace gases that are implicated in global warming. Based on present and projected use of fossil fuels, the atmospheric concentration of CO_2 could reach double its preindustrial value by the middle to late decades of the next century.[14] CO_2 emissions accounted for nearly fifty-five percent of the warming of the planet in the 1980s.[15]

Empirical evidence from past climates on the earth, from planetary atmospheres, and from mathematical models suggests that the changes in atmospheric composition brought about by increased concentrations of CO_2 and other trace gases will alter the climate and stress the living environment. Scientific studies cannot be certain about the precise amount, timing, or pattern of change, but it seems reasonably certain that ecosystems, shorelines, agriculture, and many other aspects of the environment will be affected adversely.[16]

The scientific evidence and consensus about global change have led not only to explicit U.S. acceptance of the reality of climatic change, but also to the creation of policies directed at stabilizing GHGs.[17] The U.S. National Energy Strategy, designed by President Bush as "a clear energy

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14. U.S. DEP'T OF ENERGY, REPORT OF THE DOE MULTI-LABORATORY CLIMATE CHANGE COMMITTEE, ENERGY AND CLIMATE CHANGE 139 (1990) [hereinafter ENERGY AND CLIMATE CHANGE].

15. According to IPCC and Environmental Protection Agency (EPA) estimates, the world must *reduce* CO_2 emissions by 50-80% to stabilize the atmosphere. U.S. CONGRESS, OFF. OF TECH. ASSESSMENT, CHANGING BY DEGREES 4-5 (1991) [hereinafter CHANGING BY DEGREES].

16. ENERGY AND CLIMATE CHANGE, *supra* note 14, at 139.

17. *U.S., Western Europe Reach Compromise on Dealing with Greenhouse Effect Gases*, 13 Int'l Env't Rep. (BNA) 479 (1990); NATIONAL ENERGY STRATEGY, *supra* note 6, at 172 (1991). *See* Richard B. Stewart & Jonathan B. Wiener, *The Comprehensive Approach to Global Climate Policy*, 9 ARIZ. J. INT'L & COMP. L. (forthcoming 1992).

blueprint to take the U.S. into the next century,"[18] confirms the possibility of worldwide increases in temperature and sea-level rises.[19]

The NES points to uncertainties over the impacts of both temperature and sea-level rises, but elucidates that these uncertainties do not affect the fact that temperatures and sea levels will rise. The difficulties appear to surround the extent rather than the existence of global warming. According to the NES, the U.S. objective is to stabilize the combined GWP of all GHGs at or below 1990 levels by 2000 if possible and maintain this through 2030.[20]

It is important to understand that the United States intends to stabilize the total negative impact in the atmosphere of all GHGs taken together, but is not willing to commit to specific reductions of any single gas. Hence the United States refuses to agree to specific restrictions on CO_2 emissions. The United States is the world's largest emitter of GHGs, including CO_2, accounting for approximately twenty-one percent of all emissions.[21] In fact, under the NES, U.S. carbon dioxide emissions by 2015 will increase from 1990 levels by twenty-five percent and will be maintained at that level through 2030. Furthermore, the United States opposes any treaty regime setting timetables for specific reductions of CO_2.[22] The main reductions to GWP will be through the reduction of CFCs.[23]

There is a striking difference between the objectives of the United States and other Organization for Economic Cooperation and Development (OECD) countries. These OECD countries, unlike the United States, are willing to act upon the recommendations of the IPCC, which estimates that CO_2 will contribute to sixty-one percent of global warming over a 100-year period based on 1990 emissions of all GHGs.[24] In order to stabilize the atmospheric concentration of CO_2, the IPCC believes global CO_2 emissions "must eventually be cut by at least 60-80 percent—to about 2 billion tons

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18. Michael C. MacCracken, *Preface* to ENERGY AND CLIMATE CHANGE, *supra* note 14.

19. NATIONAL ENERGY STRATEGY, *supra* note 6, at 172.

20. *Id.* at 176.

21. CHANGING BY DEGREES, *supra* note 15, at 5.

22. *See supra* note 5.

23. CHANGING BY DEGREES, *supra* note 15, at 5.

24. IPCC SCIENTIFIC ASSESSMENT, *supra* note 2, at 61.

annually."[25] Most OECD industrial countries are agreeable to stabilizing CO_2 emissions, holding them to 1990 levels by the year 2000.[26] Other nations are even willing to undertake subsequent reductions up to twenty to thirty percent.[27] It is important, therefore, to examine why there is such a divergence in approaches between the United States and its OECD partners.

Initially, the United States opposed any measures to reduce CO_2 emissions on two grounds. The United States objected first because of uncertainty surrounding the fact of global warming,[28] and second because significant CO_2 emissions reductions would interfere with economic growth and the free market.[29] In the face of overwhelming evidence, the United States conceded that global warming is taking place,[30] but argued that uncertainty surrounded the extent to which CO_2 emissions are responsible for such warming.[31] This initial response matured into U.S. advocacy of a "comprehensive approach" that addresses the GWP of all GHGs, not merely CO_2. The United States continues to maintain its case for a comprehensive approach on environmental and economic grounds.

The environmental facet of the argument primarily is based on the environmental impact of all four major trace gases. The rationale for USCA is described in the National Energy Strategy:

> Increased concentrations in the atmosphere of each GHG increase the trapping and reflection of radiative heat back to Earth's surface. Therefore, management of this single effect provides special opportunities to reduce costs and to increase the flexibility of effective responses by considering all of the GHG's.
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> Each GHG comes from different sources, including energy, agriculture, and industry, and is removed by different "sinks" such as forests. The

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25. WORLDWATCH INST., STATE OF THE WORLD 1991, at 25 (1991). *See also* IPCC SCIENTIFIC ASSESSMENT, *supra* note 2, at 5; POLICY OPTIONS FOR STABILIZING GLOBAL CLIMATE 9 (Daniel A. Lashof & Dennis A. Tirpak eds., 1990) [hereinafter EPA POLICY OPTIONS] (report prepared for U.S. Congress by Office of Policy, Planning, and Evaluation, U.S. Environmental Protection Agency).

26. *See supra* note 3.

27. *See supra* note 4.

28. Philip Shabecoff, *European Officials Dispute Bush Over Global Warming*, N.Y. TIMES, Apr. 18, 1990, at B4.

29. Philip Shabecoff, *Bush Asks Cautious Response to Threat of Global Warming*, N.Y. TIMES, Feb. 6, 1990, at A1.

30. *U.S., Western Europe Reach Compromise on Dealing with Greenhouse Effect Gases*, 13 Int'l Env't Rep. (BNA) 479 (Nov. 21, 1990).

31. *Too Cool on Global Warming*, N.Y. TIMES, Feb. 8, 1990, at A28.

> comprehensive approach considers all these GHG's, sources, and sinks together .... [I]t provides the best design for any efforts to limit emissions (whether through technology or regulation). It ensures that one GHG is not reduced while another is inadvertently increased, a lesson learned from traditional environmental policy. And it provides nations the flexibility to choose their least costly mix of policies addressing the diverse GHG's, sources, and sinks.[32]

Secondarily, the environmental argument is based on the fact that GHGs are removed from the atmosphere by "sinks" such as trees, phytoplankton, ocean mixing, and chemical reactions. The United States argues that the expansion of these sinks can be an effective part of the goal of reducing GHGs, at potentially lower cost per molecule than restrictions on the emissions of GHGs.[33]

The economic argument in essence is that CO_2 emissions reductions would hurt the United States more than other countries. It is argued that proposals for reducing CO_2 emissions are made by nations that would enjoy a competitive advantage by reason of their ability to rely on noncarbon or low-carbon energy sources such as nuclear, hydropower, or natural gas more cheaply than the United States or possibly to conserve energy more cheaply than the United States.[34] As a result, the United States has concluded that it would be better to adopt a comprehensive approach that considers all sources and sinks together and obligates each nation to meet limits for its total combined or net contribution to emissions affecting global climate.[35] Both the environmental and economic arguments of the United States are misconceived.

A. Problems With the Environmental Dimension of USCA

Contrary to the implications of the U.S environmental argument, the IPCC in fact accepted the theoretical basis for dealing with GWP presently advocated by the United States. However, compelling reasons led the IPCC to conclude that the only practical way of controlling GWP is by placing restrictions on CO_2 emissions. It is necessary, however briefly, to recapitulate the reasoning process this eminent group of international scientists used to arrive at its conclusion.

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32. NATIONAL ENERGY STRATEGY, *supra* note 6, at 180.

33. Global Climate Seminar, *supra* note 7, at 6.

34. Stewart & Wiener, *supra* note 6, at 80.

35. Global Climate Seminar, *supra* note 7, at 7.

In determining the GWP of GHGs,[36] the IPCC attached importance to absorptive capacity. The absorptive capacity of a gas is measured by determining the extent of its radiative forcing (RF). When evaluating radiative forcing, the IPCC found that over a 20-year horizon, methane, nitrous oxides, CFC-11, CFC-12, and HCFC-22 create a much greater warming effect in the atmosphere per kilogram than CO_2.[37] However, over a 100-year period this detrimental capacity was reduced,[38] and even further diminished over a 500-year period.[39]

Absorptive capacity is only one of four critical factors that determine the GWP of a gas. The other three factors are its lifetime, volume, and synergistic quality in the atmosphere. When compared to the other trace gases, what emerges as significant is the much greater volume and exceptional persistence of CO_2. The IPCC figures based on 1990 anthropogenic emissions show that there were 26,000 teragrams of CO_2 emissions as against 300 of methane, 6 of nitrous oxide, 0.9 of CFCs, and 0.1 of HCFC-22. When the IPCC calculated the volume and RF of all trace gases to ascertain their impact, the cumulative contribution of all trace gases over a 100-year period was found to be: carbon dioxide, 61%; methane, 15%; nitrous oxide, 4%; CFCs, 10.8%; HCFC-22, 0.4%; and others, 8%.[40]

Before the IPCC could formulate response strategies, it was necessary to investigate the many sources of anthropogenic emissions and their relative contributions to the atmospheric concentrations of GHGs and to the change in RF from 1980 to 1990. It found that anthropogenic emissions arose primarily from energy production and use caused by burning of fossil fuels (46%); nonenergy industrial activities primarily caused by the production and use of CFCs (24%); changes in land-use patterns primarily caused by deforestation and biomass burning (18%);

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36. The IPCC concluded that the "GWP depends on the position and strength of the absorption bands of the gas, its lifetime in the atmosphere, its molecular weight and the time period over which the climate effects are of concern." IPCC SCIENTIFIC ASSESSMENT, *supra* note 2, at 45.

37. The specific IPCC findings were that methane is 63 times, nitrous oxides 270 times, CFC-11 4500 times, CFC-12 7100 times, and HCFC-22 4100 times more effective in trapping radiative heat than CO_2. *Id.* at xxi tbl.3.

38. The relative RF of the gases decreased over the 100-year timeframe as follows: methane became 21 times; nitrous oxides 290 times; CFC-11 3500 times; CFC-12 7300 times; and HCFC-22 1500 times more effective than CO_2. *Id.*

39. The RF of methane, nitrous oxides, CFC-11, CFC-12, and HCFC-22 was reduced even further to 9, 190, 1500, 4500, and 510 times that of CO_2, respectively. *Id.*

40. *Id.* at 61 tbl.2.9.

TABLE 1

Global Warming Potentials

The warming effect of an emission of 1kg of each gas relative to that of CO_2. These figures are best estimates calculated on the basis of the present day atmospheric composition.

	Time Horizon 20 yr	100 yr	500 yr
Carbon dioxide	1	1	1
Methane (including indirect)	63	21	9
Nitrous oxide	270	290	190
CFC-11	4500	3500	1500
CFC-12	7100	7300	4500
HCFC-22	4100	1500	510

Source: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT xxi tbl.3 (J.T. Houghton et al. eds., 1990).

agricultural uses (9%); and others (3%).[41]

The Response Strategy Working Group of the IPCC identified measures to limit net greenhouse gas emissions and to increase the ability of society to adapt to the foreseeable consequences of significant future global warming. They eschewed policies that focused on only one group of emission sources, and specifically called for a balance of abatement options among the energy, industry, forestry, and agricultural sectors.[42] These measures included those that limit emissions from greenhouse gas sources (such as energy production and use); those that increase the use of natural sinks (such as forests and other biomass); and those that artificially enhance the capacity of natural sinks (such as the oceans). Based on their expert analysis of an abundance of information, the IPCC called for the

41. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC RESPONSE STRATEGIES xxix fig.1 (1991) [hereinafter IPCC RESPONSE STRATEGIES].

42. *See id.* at xxxiv.

TABLE 2

The Relative Cumulative Climate Effect of 1990 Man-Made Emissions

	GWP (100yr horizon)	1990 Emissions (Tg)	Relative contribution over 100yr
Carbon dioxide	1	26000*	61%
Methane**	21	300	15%
Nitrous oxide	290	6	4%
CFCs	Various	0.9	11%
HCFC-22	1500	0.1	0.5%
Others**	Various		8.5%

* 26 000 Tg (teragrams) of carbon dioxide = 7 000 Tg (=7 Gt) of carbon.

** These values include the indirect effect of these emissions on other greenhouse gases via chemical reactions in the atmosphere. Such estimates are highly model dependent and should be considered preliminary and subject to change. The estimated effect of ozone is included under "others". The gases included under "others" are given in the full IPCC report.

Source: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT xxi tbl.4 (J.T. Houghton et al. eds., 1990).

following reductions to stabilize the atmospheric concentration of GHGs at today's levels: carbon dioxide, 60%; methane, 15-20%; nitrous oxide, 70-80%; CFC-11, 70-75%; CFC-12, 75-85%; and HCFC-22, 40-50%.[43]

In determining how to achieve their targets, cogent reasons led the IPCC not to concentrate on the reduction of CFCs, nitrous oxides, and methane. CFCs already are controlled by the Montreal Protocol,[44] which mandates an eventual total ban on their production and use. Methane and nitrous oxides, on the other hand, are not controlled by existing interna-

43. IPCC SCIENTIFIC ASSESSMENT, *supra* note 2, at xvii tbl.2, 5-6.

44. Montreal Protocol, *supra* note 10.

tional agreements. Still, the diffuse and disparate nature of the sources of these gases presents significant difficulties in their monitoring and control. Methane emissions arise from rice cultivation, landfills, and natural gas leaks, while nitrous oxides are emitted from fertilizer use. Emissions from such sources would be extremely difficult to limit. These difficulties are compounded by the fact that the processes by which agricultural activities release methane and nitrous oxide are not well understood.[45]

Furthermore, controlling the diffuse and disparate sources of methane and nitrous oxide emissions raises intractable problems within a primitive and embryonic system of international law. This system is characterized by the absence of law-making, law-enforcing, or law-interpreting bodies. Such difficulties can be solved only by a more developed legal system. Limiting GWP arising from methane and nitrous oxide emissions creates obstacles of an operational and decisional nature. The operational problems emerge because of the difficulty of controlling methane emissions at the numerous diffuse sources like rice paddies, livestock systems and landfills, or controlling nitrous oxide and methane emissions from biomass burning. The absence of monitoring mechanisms prevents the identification of these emissions with the accuracy possible in a power plant or refinery. There are few monitoring networks for rice paddies, livestock, or burning of biomass. We need only recall the difficulties besetting the control of water pollution runoff arising from nonpoint sources such as fields and roads to understand the magnitude of the problem.[46]

Even if a satisfactory monitoring network were established, there arise decisional problems of fixing emissions standards that will ensure that the cumulative GWP of these gases will not be exceeded. This is difficult enough when dealing with reasonably identifiable emissions such as CO_2. It will be almost impossible to expect nations to set such standards for nitrous oxide and methane emissions. The United States should be particularly appreciative of this problem, given the obstacles encountered by states in the development of "state implementation plans" to control the major ("criteria") pollutants as required under the Clean Air Act.[47] These

45. IPCC SCIENTIFIC ASSESSMENT, *supra* note 2, at 5.

46. *See, e.g.*, CONSERVATION FOUND., STATE OF THE ENVIRONMENT, *supra* note 12, at 123-28.

47. Noel de Nevers, *Enforcing the Clean Air Act of 1970*, SCI. AM., June 1973, at 14, 18-20. Many difficulties surround the rollback or diffusion models that enable officials to predict the amount by which specific sources will have to cut back on emissions to achieve a predetermined ambient air quality. *See, e.g.*, Texas v. EPA, 499 F.2d 289, 297

drawbacks are compounded by the absence of monitoring networks when dealing with nitrous oxides or methane. Finally, assuming that these problems can be overcome, there emerges an even more sensitive issue of supervising or policing the system to ensure compliance. Since the international community does not possess administrative agencies capable of monitoring results, it is important to settle for easily identifiable standards, compliance with which can be checked with comparable ease.

For these sound reasons the IPCC, while recognizing the desirability of controlling all GHGs, decided that the most efficacious response strategy was to concentrate on the reduction of CO_2 emissions. The United States, on the other hand, refuses such an approach and continues to adhere to its "comprehensive approach." Importantly and exasperatingly, for the reasons just noted, it seems that a comprehensive approach of the kind demanded by the United States will only frustrate the reduction of GHGs, miring the goal in intractable difficulties of implementation.

B. Problems With the Economic Dimension of USCA

The economic argument of the United States responds to the IPCC suggestion that global CO_2 emissions eventually must be cut by at least sixty to eighty percent—to about two billion tons annually.[48] The U.S. position in essence is that such a reduction would require no less than an elemental change of direction. According to the current Administration, the nature of the uncertainty surrounding global change does not, however, justify the economic and social trauma demanded by such a fundamental shift of energy policies.[49] At this juncture, the United States is willing to adopt policies and measures that can be fully justified for reasons other than climate change, but that also produce climate change benefits.[50]

(5th Cir. 1974); Cleveland Electric Illuminating Co. v. EPA, 572 F.2d 1150, 1161 (6th Cir.), *cert. denied*, 435 U.S. 996 (1978).

48. *See supra* text accompanying note 25.

49. ECONOMIC REPORT OF THE PRESIDENT 210-24 (Feb. 1990); Philip Shabecoff, *Bush and Europeans Disagree on Warming*, N.Y. TIMES, Apr. 18, 1990, at B4.

50. *See generally* NAT'L OCEANIC AND ATMOSPHERIC ADMIN., NAT'L SCI. FOUND., & NAT'L AERONAUTICS AND SPACE ADMIN., ECONOMICS AND GLOBAL CHANGE: NEW HAVEN WORKSHOP (May 1990); Peter M. Morrisette & Andrew J. Plantinga, *The Global Warming Issue: Viewpoints of Different Countries*, 103 RESOURCES 2 (1991).

These "no regrets" climate change strategies[51] come in a variety of forms. One example is the implementation of measures under the Clean Air Act Amendments of 1990, which call for reductions in the emissions of the precursors of GHGs—nitrogen oxides and volatile organic compounds (VOCs).[52] These precursor gases react in the atmosphere to form tropospheric ozone that exerts a radiative forcing effect. Another example is the U.S. Congressional mandate for the reduction of sulphur dioxide emissions under the Clean Air Act Amendments of 1990,[53] an effort that will encourage energy efficiency. In addition, the requirement to phase out the production and use of CFCs and HCFCs (hydrochlorofluorocarbons) under the Montreal Protocol[54] and the provisions of the Clean Air Act Amendments of 1990 that implement it[55] will reduce GHGs as well as protect the stratospheric ozone layer. Furthermore, the Administration's proposal to plant one billion trees each year will increase absorption of CO_2 in addition to providing habitat for wildlife and reducing soil erosion. The increase in the federal gasoline tax enacted in the Budget Reconciliation Act of 1990 will reduce emissions of CO_2 by encouraging greater efficiency.[56]

These "no regrets" policies and the National Energy Strategy (NES) are based upon the fundamental premise that world and U.S. energy demand will increase significantly—perhaps by as much as seventy-five percent. The NES foresees that most of this additional energy demand will be met by increased consumption of coal, oil, natural gas, and nuclear power.[57] As a consequence, the strategy envisions that CO_2 emissions will increase by twenty-five percent through 2015 and then be maintained at or below that level through 2030.[58] Such a result clearly would conflict with the IPCC recommendation that CO_2 emissions be reduced significantly over that timeframe. The frustrating reality is that the U.S. vision of

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51. *See, e.g.*, C. Boyden Gray & David B. Rivkin, Jr., *A "No Regrets" Environmental Policy*, 83 FOREIGN POL'Y 47 (1991) (discussing the Bush Administration's "no regrets" policy).

52. 42 U.S.C.S. §§ 7511-7511f (Law. Co-op. Supp. 1991).

53. 42 U.S.C.S. §§ 7651b-7651e (Law. Co-op. Supp. 1991).

54. Montreal Protocol, *supra* note 10.

55. 42 U.S.C.S. §§ 7671-7671g (Law. Co-op. Supp. 1991).

56. *See, e.g.*, AMERICA'S CLIMATE CHANGE STRATEGY, *supra* note 6, at 2 (proposing programs promoting the adoption of energy efficient technology and practices as a way to reduce GHG emissions). The measures taken by the United States under the "no regrets" policy are catalogued in NATIONAL ENERGY STRATEGY, *supra* note 6, at 181.

57. NATIONAL ENERGY STRATEGY, *supra* note 6, at A5-A8.

58. *Id.* at 179.

increased CO_2 emissions is shortsighted: it perfunctorily considers and glosses over the possibilities of energy efficiencies, conservation, and alternative energy paths that if pursued would lead to lower CO_2 emissions.

The NES fails because it effectively rejects the combined benefit of the above triad as offering a solution to increased demands for energy.[59] In this article, the next two sections will demonstrate how a true comprehensive approach (TCA), unlike the specious approach presently advocated by the United States, represents a genuine "no regrets" policy. A TCA would not be economically crippling. On the contrary, energy policies would be liberated from their present straightjackets, giving the United States a veritable win-win position.

III. A TRUE COMPREHENSIVE APPROACH (TCA): AN OUTLINE

Climatic change admittedly is an unprecedented multimedia pollution problem that affects atmospheric, aquatic, and terrestrial environments. Its complexity and magnitude, however, should not camouflage the fact that global warming is essentially a problem of pollution caused by energy generation, transportation, and use. The phenomenon of global warming should have focused attention on the link between energy and pollution, illuminated the bared nexus between energy and the environment,[60] and shocked the United States into taking a fresh look at energy pollution.

Unfortunately, the enormity of the problem has misled the United States into analyzing global warming as if it lay beyond the pale of pollution. This mistake has resulted in a search for solutions that largely ignore the principles governing pollution. This erroneous approach has generated the descriptive and prescriptive errors that this article addresses. This section first will argue that global warming should be treated as a problem of energy pollution within the analytic of a TCA. The fact that global warming is a particularly egregious and difficult case of pollution does not compel exempting global warming from a TCA analytic.

A TCA confronts the subject of energy pollution, traces its sources to the web of decision-making surrounding the energy sector, and argues that

59. The World Energy Conference of 1989 expressed skepticism about the claims for conservation more openly. *See* WORLD ENERGY CONFERENCE, ENERGY FOR TOMORROW (1990) (Digest of the World Energy Conference, 14th Congress, in Montreal, Canada, 1989).

60. Lakshman D. Guruswamy, *Energy and Environmental Security: The Need for Action*, 3 J. ENVTL. L. 209 (1991).

the most satisfactory method of dealing with energy pollution is based on an integration of energy and environmental policies. An examination of the sources of pollution, enmeshed within the framework of socioeconomic decision-making, manifests the interlocking and inseparable worlds of socioeconomic and environmental decision-making.[61]

There can be no doubt about the profound implications of applying the analytic of a TCA to the sources of energy pollution. To the extent that fossil fuels are the cause of energy pollution, the analysis will pose excruciatingly difficult questions about our continued reliance on the energy derived from cheap and abundant fossil fuels. The importance of massive reservoirs of inexpensive, usable energy cannot be overestimated. The colossal array of activities required to satisfy the demands of modern society is fuelled and powered by cheap and abundant energy. It is almost a truism that the most important reason for the unprecedented prosperity and luxurious life-style of the developed world is the availability of inexpensive and abundant energy,[62] primarily derived from the combustion of fossil fuels.

A TCA begins by assessing the environmental impact of a given source and use of energy. This includes an evaluation of all socioeconomic impacts. Some of the impacts of fossil fuel pollution include environmental damage, energy insecurity, and resource depletion affecting future generations. A TCA proceeds to determine how adverse environmental impacts might be countered. In order to arrive at the right answers, a source by source evaluation of all relevant energy options is undertaken.

The TCA analysis of this article endorses and develops Holdren's largely ignored guidelines for evaluating energy options.[63] First, the impacts of inputs, pathways, stresses, and responses of differing energy sources are analyzed. This is followed by a systematic and comprehensive comparison of the impacts produced by alternative energy options. Finally, the most beneficial energy paths are selected.

The traditional sources of energy are coal, natural gas, oil, and nuclear power. The renewable sources are solar, wind, hydro, geothermal, biomass, and conservation (or efficiency). Conservation must be included as a source because a barrel saved is a barrel earned—energy then becomes

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61. *See* WORLD COMM'N ON ENV'T AND DEV., OUR COMMON FUTURE 310-11 (1987).

62. BARBARA WARD & RENÉ J. DUBOS, ONLY ONE EARTH 9-10 (1972).

63. John P. Holdren, *Environmental Impacts of Alternative Energy Technologies for California, in* U.S. DEP'T OF ENERGY, DISTRIBUTED ENERGY SYSTEMS IN CALIFORNIA'S FUTURE: INTERIM REPORT VOLUME II (HCP/P7405-03, May 1987).

available for other uses. Apart from conservation, every other source of energy—from traditionals like coal, natural gas, oil, and nuclear power to renewables such as solar, wind, hydro, geothermal, and biomass—usually pass through a sequence of stages from discovery to final application. These stages traverse exploration, harvesting, concentration, refining, conversion, transportation, storage, marketing, and end use. Each stage involves a number of phases. Characteristically, the phases include research and development, commercial construction, operation and maintenance, dismantling, and management of wastes. The impact of each source at each stage and phase is assessed under a TCA.

The environmental "inputs" from the stages and phases of energy development include direct intentional physical damage or transformation caused by blasting, terrain modification, vegetation removal, erection of structures, and unintentional harm caused by accidents. Also included are material effluent, wastes, heat, noise, and electromagnetic radiation arising from the various activities just described. Inputs may also include sociopolitical or socioeconomic inputs arising from the redistribution of population, changes in lifestyle, and health vulnerabilities. It is important to recognize that the exhaustion or preemption of resources such as land, materials, water, air, and energy that may be tantamount to a denial of these resources to future generations may also be classified as an input.

The "pathways" of an impact embrace air, water, and land. The polluting effects of energy development may enter one medium or pathway at the source but move across media boundaries and reach the receptor through more than one medium.[64] "Impacts" refer to how inputs that find their way through pathways affect humans and the environment. They include reduced resource availability, pollution of air, water, land and biota, harm to human health, damage to habitat and ecosystems, altered hydrology, changes to climate, and possibilities of social and political disruptions arising, for example, from conflicts over access to energy.

The analytic outlined above can be applied in a variety of ways. The following section of this article will delineate an approach that begins with an evaluation of the true impacts of fossil fuels. Then, based on existing legislative and administrative developments, it will explore a new path that may be taken.

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64. Lakshman D. Guruswamy, *The Case for Integrated Pollution Control*, 54 LAW & CONTEMP. PROBS. 41, 42 (1991).

IV. APPLYING A TRUE COMPREHENSIVE APPROACH[65]

A. Environmental Impacts

Vast resources are used by governments, agencies, and industry to neutralize the adverse impacts of fossil fuels. When fossil fuels—whether coal or oil—are burned, pollutants in the form of CO_2, sulphur dioxide, nitrogen oxides, and a variety of particulates are released. The United States spends approximately 80 billion dollars on pollution control today, and this is projected to rise to 160 billion dollars by 2000.[66] A significant portion of these expenses can be attributed to the effects of fossil fuels. Fossil fuels create problems of acid rain, urban smog, the disposal of sludge,[67] and hazardous chemicals that are manifested in air, water, and land.[68] The continued emission of GHGs at present rates would commit us to increased atmospheric concentrations for centuries ahead.[69] In these circumstances it behooves us to consider the possible environmental costs of climatic change. The need to do so becomes especially poignant in light of the fact that according to the IPCC, climatic changes may be even more serious than their initial predictions.[70]

According to the IPCC, sea level may rise by as much as one meter during the next century, inundating hundreds of thousands of kilometers of coastline. In the United States, it has been estimated that the costs of protecting shorelines from rising seas could range from twenty-five billion to eighty billion dollars.[71] For the world, it has been estimated that coastal defenses alone would cost $500 billion by the year 2000. This sum does not take account of land surrendered to the oceans, the loss of ecosystems, or the impact of increased storm frequencies. Consequently, the overall figure will be considerably higher.[72]

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65. Much of this section is excerpted from or based upon Lakshman Guruswamy, *Integrated Environmental Control: The Expanding Matrix*, 22 ENVTL. L. 77 (1992).

66. U.S. GEN. ACCT. OFF., ENVIRONMENTAL PROTECTION 17 (1991).

67. NATIONAL ENERGY STRATEGY, *supra* note 6, at 144.

68. COUNCIL ON ENVTL. QUALITY, TOXIC SUBSTANCES 1 (1971).

69. CHANGING BY DEGREES, *supra* note 15, at 46.

70. IPCC SCIENTIFIC ASSESSMENT, *supra* note 2, at xii.

71. THE POTENTIAL EFFECTS OF CLIMATE CHANGE ON THE UNITED STATES 345 (Joel B. Smith & Dennis A. Tirpak eds., 1989) (report to Congress of U.S. Environmental Protection Agency) [hereinafter POTENTIAL EFFECTS].

72. IPCC RESPONSE STRATEGIES, *supra* note 41, at 136, 152.

"Two-thirds of the world's fish catch, and many marine species, depend on coastal wetlands for their survival."[73] If hard structures like levees and sea walls are constructed to protect coastal lands, the ingress and egress of fish into these areas will be blocked. The adverse impact on fish stock is difficult to calculate.[74] "Eight to ten million people live within one meter of high tide in each of the unprotected river deltas of Bangladesh, Egypt and Vietnam. Half a million people live in archipelagoes and coral atoll nations that lie almost entirely within three meters of sea level, such as the Maldives, the Marshall Islands, Tuvalu, Kiribati, and Tokelau."[75] There is no likelihood of these nations finding the staggering sums of money required for sea defenses, and it is almost certain that the sea will claim many lives[76] or create environmental refugees.[77] Account must be taken of the utilitarian and nonutilitarian values destroyed by such disastrous changes.

The ecological damage caused by global warming to coastal and estuarine regions could be incalculable. Species will be destroyed. "[E]ach species provides a service to its environment; each species is a part of an immensely complicated ecological organization, the stability of which rests on the health of its components."[78] The effect of such destruction is that the whole planet's evolutionary heritage—its genetic diversity—will be put in jeopardy. Mathews has pointed out accurately that the only reason species loss is not a front page issue is that the majority of species have not yet been discovered. The few conservation biologists who can even guess at the number of species that are vanishing think that twenty percent of all the species now living will be extinct by the year 2000—without global warming.[79] Global warming dramatically will increase this figure. The losses could be economically devastating.

Genetic resources are also an important source of materials for energy and construction, chemicals for pharmaceuticals and industry, vehicles for health and safety testing, and natural pest controls. Once they are lost, they will be lost forever. Ironically, genetic resources will be lost

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73. *Id.* at 136.

74. *See id.*

75. *Id.* at 135.

76. LYNNE T. EDGERTON, THE RISING TIDE 36 (1991).

77. *Id.* at 79.

78. 119 CONG. REC. 25,668 (1973) (remarks of Sen. Tunney arguing for the Endangered Species Act).

79. Jessica Mathews, *Redefining Security*, FOREIGN AFF., Spring 1989, at 162, 165.

"at the very moment when biotechnology makes it possible to exploit this resource for the first time."[80] To assume that we could do without genetic resources is to make one massive false negative that could have devastating consequences. Increase in the global rate of extinction increases the vulnerability of the human species to extinction.[81] Accordingly, human self-interest is best served by preserving ecological systems and their functioning parts.[82]

Additionally, ecosystems support natural resources such as fish. If they are destroyed, humans will lose a vital source of food. There is a material exchange between salt marshes and coastal waters. The outwellings of nutrients and organic detritus from salt marshes feed large areas of adjacent waters such as estuaries. This enrichment of estuaries helps to support an abundance of animal life and serves as the feeding and breeding ground of fish and bird life.[83] A destruction of salt marshes as a result of global warming therefore will have painful economic consequences.

Modeling studies have suggested that increased CO_2 concentrations could slow the atmospheric heat engine that is driven by the differences between equatorial and polar climates. This could change the hydrological cycle and affect rainfall patterns.[84] Tropics and eastern coasts of conti-

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80. *Id.*

81. PAUL EHRLICH & ANNE EHRLICH, EXTINCTION: THE CAUSES AND CONSEQUENCES OF THE DISAPPEARANCE OF SPECIES 6 (1981). The authors preface their book with a parable called the "Rivet Poppers." A person boards an airplane for a flight but notices a workman prying rivets out of the wings. When questioned, the workman explains that the rivets can be sold for two dollars each, thus reducing the price of flying. Asked about the safety of the practice, the workman replies that it must be safe as it has been going on for some time and no wings have yet fallen off even after successive rounds of rivet popping. *Id.* at xi-xiv.

82. MARK SAGOFF, ECOLOGY AND LAW: SCIENCE'S DILEMMA IN THE COURTROOM 9-10 (1987) (criticizing such a view as being without adequate scientific foundation); BRYAN G. NORTON, WHY PRESERVE NATURAL VARIETY? 73-97 (1987).

83. *See* SAGOFF, *supra* note 82, at 6-9 (citing such a view in order to criticize it).

84. *See* Syukoro Manabe, *The Effect of Increasing the CO_2 Concentration on the Climate of a General Circulation Model, in* U.S. DEP'T OF ENERGY, CARBON DIOXIDE EFFECTS RESEARCH AND ASSESSMENT PROGRAM: WORKSHOP ON THE GLOBAL EFFECTS OF CARBON DIOXIDE FROM FOSSIL FUELS 100 (William P. Elliot & Lester Machta eds., 1979); *see also* RCEP TENTH REPORT, *supra* note 12, at 159; R.E. Dickinson, *How Will Climate Change?: The Climate System and Modelling of Future Climate, in* THE GREENHOUSE EFFECT: CLIMATIC CHANGE AND ECOSYSTEMS 207, 285-87 (Bert Bolin et al. eds., 1986).

nents could become wetter while subtropics could become drier and increase in area toward higher latitudes.[85] Since higher CO_2 concentrations *per se* may increase plant growth[86] and increase water-use efficiency,[87] some have concluded that increased CO_2 accumulations in the atmosphere are wholly beneficial.[88] The general consensus, however, is that increased temperatures caused by the greenhouse effect could be

85. RCEP TENTH REPORT, *supra* note 12, at 159.

86. Under laboratory conditions, increased atmospheric CO_2 conditions increase the rate of photosynthesis and nitrogen fixation in some plants. R.A. Warrick et al., *CO_2, Climatic Change and Agriculture, in* THE GREENHOUSE EFFECT: CLIMATIC CHANGE AND ECOSYSTEMS 393, 394 (Bert Bolin et al. eds., 1986).

> If increases in atmospheric CO_2 were occurring without the possibility of associated changes in climate then, overall, the consequences for agriculture would probably be beneficial. CO_2 is vital for photosynthesis, and the evidence is that increases in CO_2 concentration would increase the rate of plant growth.

MARTIN PARRY, CLIMATE CHANGE AND WORLD AGRICULTURE 37 (1990). Photosynthesis is the process by which CO_2 enables the plant to accumulate carbohydrates. Hence, a greater uptake of CO_2 helps to build more carbohydrates and increase plant productivity. *Id.*

> There are, however, important differences between the photosynthetic mechanisms of different crop plants . . . . Plant species with the C3 photosynthetic pathway . . . use up some of the solar energy they absorb in a process known as photorespiration, in which a significant fraction of the CO_2 initially fixed into carbohydrates is reoxidized back to CO_2. C3 species tend to respond positively to increased CO_2 because it tends to suppress rates of photorespiration . . . . Some of the current major food staples, such as wheat, rice and soya bean, are C3 plants.

Id. at 37-38. C4 plants such as maize, sorghum, sugarcane and millet "are less responsive to increased CO_2 levels . . . ." *Id.* at 39.

87. Stomata (microscopic pores on the leaf surface) allow the inward diffusion of CO_2 used in photosynthesis and, at the same time, allow the loss of transpired water. An increase in the atmospheric CO_2 concentration could reduce the opening of the stomata required to allow a given amount of CO_2 to enter the plant and might thus reduce the loss of water from a plant. *Id.* at 41. *See also* Warrick et al., *supra* note 86, at 402-05.

88. Sherwood Idso, for example, argues that the increase of CO_2 will lead to a greening of the planet. "[T]he whole face of the planet will likely be radically transformed—rejuvenated, as it were—as the atmospheric CO_2 content reverses its long history of decline and returns, in significant measure, to conditions much closer to those characteristic of the Earth at the time when the basic properties of plant processes were originally established. Indeed, it is the thesis of many that this 'greening of the earth' is already in progress." SHERWOOD B. IDSO, CARBON DIOXIDE AND GLOBAL CHANGE: EARTH IN TRANSITION 9 (1989).

detrimental to agriculture on the whole, and outweigh any beneficial effects of increased CO_2.[89]

Crop impact analyses show that warmer average temperatures of 1°C-4°C are detrimental to both wheat and maize yields in the Great Plains and in Western Europe.[90] This is because higher temperatures adversely affect crop moisture and hence crop growth. With no change in precipitation, an increase of 1° might decrease yields by five percent, and 2° by ten percent.[91] Average yields may be reduced by between three to seventeen percent.[92] It is plain that global warming will adversely affect agriculture, particularly in the tropics and the developing world.[93] In the United States it is estimated that a 3.8°C-6.3°C warming would be accompanied by a ten percent reduction in soil moisture.[94] On the basis of these figures a comprehensive Environmental Protection Agency (EPA) study estimates that there will be a decrease in yield of all major unirrigated crops in the United States.[95] The costs of adverse impacts on agricul-

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89. In most regions of the country, climate change alone could reduce site to site dryland yields of corn, wheat, and soybeans, with losses ranging from negligible amounts to 80%. These decreases are primarily the result of higher temperatures, which shorten a crop's life cycle. *See* ESSAM EL-HINNAWI & MANZUR H. HASHMI, THE STATE OF THE ENVIRONMENT 23 (1987) (a 2°C warming could cause a 3-17% decrease in average yields); POTENTIAL EFFECTS, *supra* note 71, at ch. 10; Warrick et. al., *supra* note 86, at 425.

90. PARRY, *supra* note 86, at 49.

91. *Id.* The estimated decrease of 5% is subject to +/- 4%, while the estimated reduction of 10% is subject to +/- 7%. *Id.*

92. *See* EL-HINNAWI & HASHMI, *supra* note 89, at 23 (citing UNEP/ICSU/WMO, *Report of the International Conference on the Assessment of the Role of Carbon Dioxide and of Other Greenhouse Gases in Climate Variations and Associated Impacts*, WMO Doc. WMO-No. 661 (1986)); *see also* THE IMPACT OF CLIMATIC VARIATIONS ON AGRICULTURE (Martin L. Parry et al. eds., 1988); Warrick et al., *supra* note 86, at 425.

93. PARRY, *supra* note 86, at 105-18.

94. These statistics are according to the Goddard Institute for Space Studies (GISS), and Geophysical Fluid Dynamics Laboratory (GFDL) general circulation models. *See Id.* at 80-83.

95. POTENTIAL EFFECTS, *supra* note 71, at 367. However, the EPA study arrives at a questionable conclusion. According to the study there will be an increase in yield in the northern United States arising from the fact that farming zones will shift 175 kilometers northward for each degree Celsius increase in warming. The study then adds the crop increases from unfrozen fields to projected increases in irrigation amounting to as much as 25% in the southern states and 10% in northern states, to arrive at a reassuring conclusion. Supplies of food will be sufficient to meet current and projected demand, though at slightly higher prices. The conclusion begs a number of questions.

ture need to be brought into any equation evaluating the impact of energy pollution.

B. Impacts on Energy Security

The world still gets nearly half of its energy from oil. In the United States, oil accounts for well over forty percent of energy use.[96] Oil prices are forecast to stay at their present low levels of under fifteen dollars per barrel. "Key projections show U.S. oil imports increasing from 5.2 million barrels per day (about one-third of the Nation's oil consumption) in 1986 to between 8 and 10 million barrels per day (about one-half of projected oil consumption) in the 1990's."[97] The United States and many of its allies and trading partners are likely to become more dependent in the future on oil imports from low-cost suppliers in the Persian Gulf. Because of the interdependent nature of the world oil market, U.S. energy supplies are inseparable from those of our allies. For example, even if oil supplies were disrupted in a country that did not export oil directly to the United States, the oil market would redirect oil from the United States to those countries whose supplies were being reduced or eliminated. This would cause world oil prices to rise, affecting consumers worldwide.[98]

In light of these facts "all recent U.S. administrations have viewed the strategic Persian Gulf region as an area of vital security interest."[99] The challenge to security arises from the extent to which the U.S. economy depends on oil. First, disruptions to the oil supply could have traumatic economic implications. Second, U.S. foreign relations could be affected to the extent that allied solidarity would be undermined by competition with our allies for scarce energy resources. Third, defense capabilities may be affected if oil supply disruptions coincide with a major defense emergency. The Gulf War has poignantly driven home our dependence on imported oil. It is no longer possible to exclude the price of energy security from the costs of fossil fuels. The price of energy security must include the costs of

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Important among these is the assumption that more irrigation water will be available. This simply is incorrect.

96. U.S. DEP'T OF ENERGY, ENERGY SECURITY: A REPORT TO THE PRESIDENT OF THE UNITED STATES 2 (DOE/S-0057, 1987).

97. *Id.* at 3.

98. *Id.* at 8.

99. *Id.*

war, loss of life, and the likelihood of a permanent military presence to ensure supplies of "cheap" oil.[100]

C. Impacts on Future Generations

The present patterns of fossil fuel consumption will exhaust nonrenewable sources of energy and deny them to posterity. Such patterns must be reevaluated because, as Burke has argued, "society is indeed a contract . . . a partnership not only between those who are living, but between those who are dead, and those who are to be born."[101] If so, present generations have intertemporal and intergenerational moral obligations, which we dishonor by depriving future generations of resources left to us by our ancestors.

The case for sharing finite resources with future generations finds strong support in John Rawls' *Theory of Justice*.[102] Rawls considers an assembly of representatives situated behind a "veil of ignorance" who will draw up a constitution. The "veil of ignorance" prevents the members of the assembly from knowing their class, position, social status, or how much property or natural resources they own. We may redefine this assembly as one in which no one has any information as to which generation she belongs, or in which generation she will be born.[103]

We may extend the Rawlsian allegory to assume that the representatives, though ignorant of their generation, have an idea of the value of resources and of their potential use. It must become evident to representatives that the material base should be preserved. In order to do so, finite, nonrenewable resources need to be shared between generations, and held in trust from one generation to another. It is unthinkable that a few generations be allowed to exploit and exhaust vital natural resources like coal, oil, and gas, leaving nothing to posterity. Were the present generation to exhaust these resources it would deprive future generations of a

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100. Lakshman D. Guruswamy, *Energy and Environmental Security: The Need for Action*, 3 J. ENVTL. L. 209, 222 (1991).

101. EDMUND BURKE, REFLECTIONS ON THE FRENCH REVOLUTION AND OTHER ESSAYS 94 (Ernest Rhys ed., J.M. Dent & Sons Ltd. 1910) (1790).

102. JOHN RAWLS, THEORY OF JUSTICE §§ 24, 44 (1971). It should be noted that Rawls himself presents the intertemporal problem as one of choosing the fair rate of saving. *Id.*

103. Rawls is dealing with the question of savings of money, and decides that it would be best to treat the assembly as if it were deciding at the present time, though it had representatives from all generations.

valuable—perhaps invaluable—resource. Oil, coal, and gas are not only sources of energy, they are minerals that may have undiscovered uses. Like biological species, they may possess yet unrealized medical or ecological values of a utilitarian nature[104] that can be translated into dollars.[105] The conclusions of the assembly must resonate to Thomas Jefferson who held that "the earth belongs in usufruct to the living."[106]

D. Alternatives

Having ascertained the costs and impacts of fossil fuel use, a TCA calls for a consideration of alternatives. Holdren's preliminary, but highly significant attempt to apply an integrated approach to alternative energy paths was undertaken in 1978[107] and was given passing notice,[108] but since then virtually has been ignored. The evaluation was made before the full magnitude of the dangers of global warming had become evident. The current state of knowledge as to the magnitude of the problem makes Holdren's findings on the efficacy of using coal and oil even more forceful. Holdren did not purport to arrive at his findings on the basis of exhaustiv-

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104. Utilitarian is used broadly as that which is of value to humans, or contributes to human happiness, pleasure, or some other substantive good. It is recognized that utilitarianism is a broad theory that subscribes to a wide "cluster of positions sharing little more than a hedonistic theory of value combined with consequentialist method of evaluating courses of action." NORTON, *supra* note 82, at 7. Sagoff also offers a definition. "Utilitarianism . . . judges the value of actions according to the degree to which their consequences increase or decrease happiness, pleasure, value, or some other substantive good." MARK SAGOFF, THE ECONOMY OF THE EARTH 105 (1988). The wide range of thinking encompassed by utilitarianism might make it too vague and inexact for more precise analysis. The term does, however, serve our purposes of identifying and distinguishing broad approaches to the problems addressed here. *See* CHRISTOPHER D. STONE, EARTH AND OTHER ETHICS 115-16 (1987).

105. For a general discussion regarding the economic utility of conserving biological species, see W. Michael Hanemann, *Economics and the Preservation of Biodiversity, in* BIODIVERSITY 193 (E.O. Wilson ed., 1988); JOHN V. KRUTILLA & ANTHONY C. FISHER, THE ECONOMICS OF NATURAL ENVIRONMENTS: STUDIES IN THE VALUATION OF COMMODITY AND AMENITY RESOURCES (1975); John V. Krutilla, *Conservation Considered*, 57 AM. ECON. REV. 777 (1967).

106. TALBOT PAGE, CONSERVATION AND ECONOMIC EFFICIENCY 174 (1977).

107. Holdren, *supra* note 63.

108. Holdren's analysis was noted in the technical part of the Global 2000 Report. U.S. COUNCIL ON ENVTL. QUALITY & U.S. DEP'T OF STATE, THE GLOBAL 2000 REPORT TO THE PRESIDENT 348-49 (1979) [hereinafter THE GLOBAL 2000 REPORT].

ely verified empirical evidence. Such conclusive evidence was lacking at the time he wrote, and he hoped that his preliminary analysis would lead to a more substantial verification of his thesis. However, his preliminary examination was far more penetrating than a merely impressionistic exercise, and was based on a coherent and rigorous analytic. Consequently, his conclusions are highly useful.

Holdren compared the impacts of a variety of traditional (hard) and nontraditional (soft) energy sources. The hard sources included coal, coal gasification, domestic gas, imported gas, imported oil, domestic oil, and nuclear power. The soft energy sources he considered were solar, wind, biomass, geothermal, and end-use efficiencies.[109]

Holdren then calculated the impacts of these sources on such areas as land use, water use, use of nonfuel material, occupational health, small and large accidents, air and water pollution, climate, ecosystems, and aesthetic effects. Holdren also considered any direct links a source of energy might have either to causing war or to being used in war.[110] He then ranked the impacts of the various sources on an order of one to five, with five denoting the most severe impact. The application of these objective criteria led to an unequivocal conclusion: the negative environmental impacts of renewable sources like solar and wind power were unquestionably less than the impacts of nonrenewable sources.[111]

The NES serves as a counterpoint to a serious consideration of alternatives. Bowing to public opinion that showed "virtually unanimous support for the development and use of renewable resources," the NES admits that renewable technologies are on the verge of successful commercialization into the mainstream energy marketplace. It proclaims that the growth of renewables will be accelerated so that they can play a

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109. Holdren, *supra* note 63, at 18-19. As discussed earlier, conservation (efficiency) must be included as a source because energy conserved becomes available for future use. *See supra* p. 129. Conservation is a source of energy for another compelling reason. Energy conservation avoids the impacts associated with the extraction, transportation, and use of a fuel. For example, if coal-generated electricity is conserved or used more efficiently, the conserved coal saves us from having to mine, process, or burn additional coal. The NES notes that "investments in electricity conservation and efficiency should be allowed to compete fairly with electricity supply options." NATIONAL ENERGY STRATEGY, *supra* note 6, at 36. However, the NES offers hardly any explanation of how end-use efficiencies are to be evaluated against the historically ingrained reliance on hefty supply-side increases of power.

110. Holdren, *supra* note 63, at 51.

111. *Id.* at 60.

larger role in meeting our energy needs.[112] Yet despite this enthusiastic acclamation of the need for renewable energy, the final figures of the NES are damning, and its goal frighteningly recidivist. The figures show that under, or more accurately in spite of,[113] today's prodigal energy policies, the share of renewable energy is set to increase from eight to twelve percent by 2030. The NES extrapolates its own goal over these projections, and under it renewable sources rise from twelve to eighteen percent by 2030.[114] In other words, the nation is directed to toil forty years to produce a diminutive six percent increase in the use of renewable energy. Even the most magnanimous and charitable view of the NES could not deny that it flatters the mountain laboring to produce a mouse.[115]

By contrast, the alternative vision to the NES is dramatically different. This alternative view accepts the need to cut CO_2 emissions by 60-80%. Facing this daunting task in light of the reality that fossil fuels account for 75% of the world's energy supplies calls for drastic measures that will reduce the use of fossil fuels by up to 90%, and will produce goods and services using one-third to one-half as much energy as today.[116] This alternative view argues that the key to meeting such reductions is energy efficiency.[117] Employing efficiencies in the way we use electricity, construct buildings, and design cars could double, even quadruple,[118] our existing energy effectiveness by stretching rather than wasting.[119] Efficiencies will buy time during which it will be possible to switch to other renewable sources of energy like wind, solar, photovoltaic, geothermal, and biomass.

112. NATIONAL ENERGY STRATEGY, *supra* note 6, at 14.

113. Amory B. Lovins, *End-Use / Least-Cost Investment Strategies, in* WORLD ENERGY CONFERENCE, ENERGY FOR TOMORROW (1990) (Digest of the World Energy Conference, 14th Congress, in Montreal, Canada, 1989) [hereinafter Lovins, *End-Use / Least-Cost*].

114. NATIONAL ENERGY STRATEGY, *supra* note 6, app. at C-25.

115. The NES attempt to disguise its meager reliance on renewables is not confined to hortatory language. It refers to a 30% increase in renewable energy. *Id.* Currently, renewables supply only 12% of total energy. A 30% increase only raises the contribution of renewables to 16% of total energy.

116. WORLDWATCH INST., *supra* note 25, at 25-26.

117. HAL HARVEY & BILL KEEPIN, ENERGY: FROM CRISIS TO SOLUTION 1 (1991).

118. *Id.* at 2; Amory B. Lovins, *Energy Strategy: The Road Not Taken?*, 55 FOREIGN AFF. 65, 72 (1976) [hereinafter Lovins, *Energy Strategy*]; Lovins, *End-Use / Least-Cost*, *supra* note 113, at 329, 332; WORLDWATCH INST., *supra* note 25, at 26 (1991).

119. Lovins, *Energy Strategy*, *supra* note 118; Lovins, *End-Use / Least-Cost*, *supra* note 113, at 329, 332.

The theoretical possibility of an all-renewable global energy future has been delineated.[120] While old and tested technologies have been used, for example, in sailing ships, windmills, watermills, hydraulic rams, solar drying and distilling, charcoal fired smelters and forges, and human and draft animal power,[121] a cluster of difficulties confronts a conversion to such renewable technologies from existing nonrenewable ones. There is a projected growth of demand for energy. The NES estimates that world energy demand that is presently at about 330 quadrillion British thermal units[122] will more than quintuple from the 1975 level by the year 2050.[123] Estimates of U.S energy demand vary from rises of 0.5 to 1.5% per year[124] to 0.2% per year.[125] It is felt that accessible sources of renewable energy and technologies capable of converting them to produce such massive amounts of energy do not exist.[126] Secondly, the cost of renewable energy has been very high compared to that of fossil fuels.[127]

The assumptions underlying the rejection of the soft energy path have been challenged. A report prepared for the U.S. Department of Energy has estimated that "the country's annual influx of accessible resources is more than 200 times its use of energy, and more than 10 times the total reserves estimated for fossil and nuclear fuels."[128] It also has been pointed out that U.S. energy use has increased only eight percent since 1973, while Gross National Product (GNP) increased forty-six percent.[129] Energy intensity (measured as total energy requirements per unit of Gross Domestic Product) improved dramatically in all OECD countries from 1970 to the present.[130] It is claimed that over the next thirty years energy efficiencies can reduce energy use per capita by between one-third and one-

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120. Jerome Weingart, *The Helios Strategy: An Heretical View of the Potential of Solar Energy in the Future of a Small Planet*, 12 TECH. FORECASTING & SOC. CHANGE 273, 273 (1978).

121. THE GLOBAL 2000 REPORT, *supra* note 108, at 346.

122. NATIONAL ENERGY STRATEGY, *supra* note 6, app. at A-2.

123. *Id.* at A-4.

124. *Id.* at A-5.

125. CHANGING BY DEGREES, *supra* note 15, at 95.

126. ORGANISATION FOR ECON. COOPERATION AND DEV., THE STATE OF THE ENVIRONMENT 228 (1991) [hereinafter OECD, STATE OF THE ENVIRONMENT].

127. NATIONAL ENERGY STRATEGY, *supra* note 6, at 119.

128. U.S. DEP'T OF ENERGY, CHARACTERIZATION OF U.S. ENERGY RESOURCES AND RESERVES (DOE/CE-0279, Dec. 1989); WORLDWATCH INST., *supra* note 25, at 26.

129. CARBON EMISSIONS CONTROL STRATEGIES 22 (William U. Chandler ed., 1990).

130. OECD, STATE OF THE ENVIRONMENT, *supra* note 126, at 225.

half in industrial countries without having a detrimental effect on their economies.[131] Furthermore, some technologies for converting renewable sources of energy are well-developed.[132] Other conversion technologies are advanced concepts in the research phase,[133] including ocean energy thermal conversion, wave and tidal generators, and solar power satellites. Still others, such as hydrogen fuel,[134] demonstrate the possibility of relying on energy "income" from renewable sources rather than depleting the energy "capital" by using nonrenewable sources. According to a study of several government scientific laboratories, renewables could supply the equivalent of fifty to seventy percent of U.S. energy needs by 2030.[135]

Moreover, the costs of renewable energy technologies have tumbled. The costs of generating electricity from wind has fallen from $0.32 per kilowatt-hour in 1980 to $0.08 in 1988; photovoltaics from $3.39 to $0.30; and solar thermal from $0.24 to $0.08. The costs of geothermal and biomass, at $0.04 and $0.05 per kilowatt hour respectively, remain cheaper than conventional (coal-derived) electricity.[136] On the basis of these trends it is predicted that electricity generated from these renewable sources of energy will be competitive with, if not cheaper than, coal-generated electricity by 2000, and positively cheaper by 2030.[137] A TCA analytic requires that the alternative "soft" energy path be considered before arriving at decisions on how to control energy pollution.

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131. WORLDWATCH INST., *supra* note 25, at 26; HARVEY & KEEPIN, *supra* note 117, at 2.

132. These technologies include wind turbines, the concentration of solar heat, photovoltaics, the use of hot water from geothermal wells, and the conversion of biomass into gaseous or liquid fuels. NATIONAL ENERGY STRATEGY, *supra* note 6, at 118. *See also National Energy Policy Act of 1989: Hearings on S. 324, Part 1, Before the Senate Comm. on Energy and Natural Resources*, 101st Cong., 1st Sess. 55, 58 (1989) (statement of John H. Gibbons, Director, Office of Technology Assessment).

133. NATIONAL ENERGY STRATEGY, *supra* note 6, at 118.

134. JOAN M. OGDEN & ROBERT H. WILLIAMS, SOLAR HYDROGEN: MOVING BEYOND FOSSIL FUELS (1989).

135. *See* IDAHO NAT'L ENG'G LABORATORY ET AL., THE POTENTIAL OF RENEWABLE ENERGY: AN INTERLABORATORY WHITE PAPER (1990), *cited in* WORLDWATCH INST., *supra* note 25, at 27.

136. WORLDWATCH INST., *supra* note 25, at 27.

137. *Id.*

V. The Path Not Taken

Comprehensive environmental impact evaluations of energy development could have been undertaken under two different rubrics: the National Environmental Policy Act (NEPA), and the National Energy Strategy (NES). Neither possibility has been utilized. Despite the integrative thrust and rationally comprehensive provisions of NEPA, it is quite clear that a comprehensive analysis of the environmental impact of federal actions affecting energy has not been undertaken through NEPA.[138] Energy agencies, including the Department of Energy, have pursued narrow missions single-mindedly and have not considered environmental impacts that might threaten the accomplishment of their primary objectives. Agency anxiety about accomplishing their primary mission has led to only rare discussions of alternatives antithetical to that mission.[139] For example, the use of nontraditional alternatives such as solar and wind power,[140] or conservation to meet increased demands for power has not been considered realistically under NEPA.[141]

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138. Paul J. Culhane, *NEPA's Impacts on Federal Agencies, Anticipated and Unanticipated*, 20 ENVTL. L. 681 (1990).

139. *Id.* at 693.

140. In Carolina Envtl. Study Group v. United States, 510 F.2d 796 (D.C. Cir. 1975), it was argued by plaintiffs that the possibility of alternative energy sources replacing the output from a proposed nuclear plant should have been considered. The court agreed that well-established alternatives should be addressed but held that less orthodox alternatives such as solar and geothermal power are speculative and remote and did not require consideration.

141. Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc., 435 U.S. 519 (1978), involved permission to build a nuclear power plant. The court prefaced its dismissal of the argument that the EIS had omitted the alternative of conservation: "[t]o make an impact statement something more than an exercise in frivolous boilerplate the concept of alternatives must be bounded by some notion of feasibility. . . . Common sense also teaches us that the 'detailed statement of alternatives' cannot be found wanting simply because the agency failed to include every alternative device and thought conceivable by the mind of man." *Id.* at 551. In a later case involving the Interior Department's program for oil leases, NRDC argued that conservation had to be considered as a partial alternative to the lease plan. The government countered that partial alternatives did not require discussion because the need for oil would not be eliminated. The court agreed that conservation must be discussed but held that the attention given to conservation was lessened because of its limited value. Natural Resources Defense Council, Inc. v. Hodel, 865 F.2d 288, 294-97 (D.C. Cir. 1988).

Additionally, the NES makes alluring assertions about the need for a comprehensive assessment of environmental impacts, and a comparison of all alternatives.[142] It also endorses the concept of Integrated Resource Planning that adopts demand-side efficiency and management, and the need to calculate the true social costs of energy development.[143] Unfortunately, the NES does not undertake environmental impact assessments, or cost evaluations of the nonrenewable sources on which it relies. Neither does it compare the environmental impacts of conventional sources with those of renewable sources. Whatever the tantalizing explanation for this contradiction, be it "garbage can" politics,[144] theories of "muddling through,"[145] or plain Machiavellianism, the failure to undertake a comprehensive environmental assessment remains a serious omission. It is all the more glaring in light of the NES mission to address the environmental impacts of energy development both within the United States and globally.[146]

Integrated Resource Planning (IRP)[147] and Total Fuel Cycle

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142. NATIONAL ENERGY STRATEGY, *supra* note 6, at 17, 145.

143. *Id.* at 35-37.

144. Michael D. Cohen et al., *A Garbage Can Model of Organizational Choice*, 17 ADMIN. SCI. Q. 1-25 (1972); JOHN W. KINGDON, AGENDAS, ALTERNATIVES AND PUBLIC POLICIES 88-94 (1984). Kingdon has applied this anti-rational theory of decision-making to federal policy innovations. He describes new federal policy innovations as arising when the initiatives of policy entrepreneurs who develop policies for new problems converge with political streams that create opportunities for the application of the entrepreneurs' ideas.

145. Charles Lindblom, *The Science of "Muddling Through,"* 19 PUB. ADMIN. REV. 79-88 (1959); GRAHAM T. ALLISON, ESSENCE OF DECISION (1971); KARL E. WEICK, THE SOCIAL PSYCHOLOGY OF ORGANIZING (1969). Here, decisionmakers with competing ideas negotiate compromises without agreeing on objectives.

146. An entire section of the NES is devoted to "Enhancing Environmental Quality." This section deals first with "Energy and the Quality of Air, Land, and Water" and second with "Energy and Global Environmental Issues." *See* NATIONAL ENERGY STRATEGY, *supra* note 6, at 143-85.

147. *Id.* at 35. IRP begins by asserting that future demand for electricity must be met by a "wide variety of investments in new generation capacity *and in programs and technologies that reduce consumption*." *Id.* (emphasis added). It then states that investments should be made on the criteria of *"the greatest net social benefits to consumers."* *Id.* (emphasis added). It goes on to point out that "investments in electricity conservation and efficiency should be allowed to compete fairly with electricity supply options." *Id.* at 36. There are several weaknesses in the NES pronouncement of IRP. First, it provides hardly any explanation of how end-use efficiencies are to be evaluated against the historically ingrained reliance on hefty supply-side increases of power.

Analysis (TFCA),[148] professed but not acted upon in the NES, represent two methods of undertaking and evaluating impacts. Unfortunately, the NES does not carry out such an evaluation. If we are to move toward the goal of confronting the specter of global warming, the true environmental and social costs of energy development, not satisfactorily dealt with either under NEPA or by the NES, need to be highlighted. This can be done

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Second, there is no mention of how the true social costs of energy, evident for example in the enormous amounts spent on controlling pollution arising from the energy sector, might be internalized. Third, there is only a muted promotion of this effete and docile rendition of IRP, and that too from a distance. All that is contemplated is for state commissions to be offered information and limited financial assistance in order that they might induce states and utilities to build effective IRP programs. The NES's faint promotion of weak IRP is redolent of the rejected and discarded strategies employed in the early stages of pollution control when states were encouraged but not required to combat nonthreateningly depicted air and land pollution.

148. NATIONAL ENERGY STRATEGY, *supra* note 6, at 148, 155-70. The rationale and definition of TFCA set out in the NES are impeccable. The need to compare the environmental and economic tradeoffs and problems associated with an energy technology and its alternatives are acknowledged. *Id.* at 155. The need to "quantify *all* impacts to health, the environment and society" is emphasized. *Id.* at 148. The NES reveals the incompleteness of existing analysis. "[A]n initiative promoting development of a new coal combustion technology may not be analyzed in regard to the environmental impacts of the added coal mining, coal cleaning, coal transportation, coal ash transportation and disposal, or disposal of sulfur pollution control wastes that are involved." *Id.* The NES continues:

> In addition to the environmental impacts normally described in physical terms (such as tons of sludge produced and increase in the temperature of receiving water), such analyses should also include the costs of complying with regulations and licensing conditions and costs to repair associated environmental damage. Still other factors—such as operating costs or environmental impacts associated with the construction of a facility and the manufacture of its capital equipment—could be included to broaden the analysis even further. For example, the price consumers pay for electricity does not always fully reflect the costs or benefits to the Nation of building and operating generating facilities. The indirect costs associated with electricity use, including the costs of some environmental and human health impacts, impose a burden on society that is not included in the price of electricity. Doing these analyses involves complexities, but it allows the comparable analysis of impacts across such disparate technologies as dispersed solar heating and centralized electric generation that employs fossil fuels.

Id. This is an admirable diagnosis, and one would expect the NES at least to begin the administration of the prescription it advocates. Alas, the search for such evidence is in vain.

under the rubric of a TCA that finds a basis in the Pollution Prevention Act of 1990 and in risk assessment and management.[149]

VI. MOVING FORWARD

The case for a TCA can be argued from the recently established baseline created by the Pollution Prevention Act of 1990 (PPA),[150] and the Administration's strong endorsement of risk assessment and risk management.[151] The PPA constitutes a critical step in our legislative history, and embodies significant features of a TCA such as pollution control at the source and pollution prevention. Admittedly, it is flawed by its narrow vision and lack of implementing strategies, but it provides a baseline from which to approach the problems of energy pollution. Similarly, risk management sets priorities among the risks presented by pollution, and chooses appropriate action for the risks so selected. Thus, risk management converges with a TCA.

In enacting the PPA, Congress concluded that there are significant opportunities for reducing or eliminating the billions of dollars spent on controlling pollution. It recognized that opportunities for source reduction often are not realized because existing regulations, and the industrial resources they require for compliance, focus upon treatment and disposal rather than "source reduction."[152] Accordingly, the PPA embraced the need for cost effective changes in production, operation, and raw material that would reduce or prevent pollution at the source.

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149. Although NEPA and the integrative mechanisms professed in the NES have not adequately been defined and utilized, they could be linked to the Pollution Prevention Act and to risk assessment and management to create a framework in which to implement TCA.

150. 42 U.S.C.A. § 13101 (West Pamph. 1991).

151. *See* U.S. ENVTL. PROTECTION AGENCY, UNFINISHED BUSINESS: A COMPARATIVE ASSESSMENT OF ENVIRONMENTAL PROBLEMS (Volume I Overview) (1987) [hereinafter EPA, UNFINISHED BUSINESS]; U.S. ENVTL. PROTECTION AGENCY, REDUCING RISK: SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION (1990) [hereinafter EPA, REDUCING RISK]; William Reilly, *Taking Aim Toward 2000: Rethinking Our Nation's Environmental Agenda*, 21 ENVTL. L. 1359 (1991).

152. The PPA defines source reduction as "any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering the waste stream . . . ." Source reduction includes "equipment technology modifications, process or procedure modifications, reformulation or redesign of products, [and] substitution of raw materials . . . ." 42 U.S.C.A. § 13102(5)(A) (West Pamph. 1991).

The PPA accepts the need for multimedia management.[153] It finds that "source reduction is fundamentally different and more desirable than waste management and pollution control" and that the "Environmental Protection Agency needs to address the historical lack of attention to source reduction."[154] The PPA further crystallizes some essentials of a TCA by declaring that current U.S. policy is that pollution should be prevented or reduced at the source whenever feasible.[155] The PPA charges the EPA Administrator with developing and implementing a strategy promoting source reduction.[156]

The *ex ante* approach to pollution control embodied in PPA is a far cry from the *ex post* laws and policies to which we have become accustomed. But while PPA is a significant step forward, it is unable to address the fundamental restructuring demanded by energy pollution.[157] Viable preventive technologies or processes for removing CO_2 from fossil fuels simply do not exist. The measures necessary to prevent or reduce fossil fuel pollution at the source require changes of the kind envisioned by a TCA. Therefore, in order to deal with energy pollution we need to advance from the preliminary steps taken by PPA to the TCA advocated by this article.

Risk assessment offers both a framework and a quantitative measure for achieving some of the objectives of a TCA. According to an influential

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153. 42 U.S.C.A. § 13101 (West Pamph. 1991).

154. 42 U.S.C.A. § 13101(a)(4) (West Pamph. 1991).

155. 42 U.S.C.A. § 13101(b) (West Pamph. 1991).

156. 42 U.S.C.A. § 13103(b) (West Pamph. 1991).

157. It is wise to guard against false hope. Although the declaration in PPA shifting the focus of pollution control from effects to sources resonates with prophetic cadences, 42 U.S.C.A. § 13101(b) (West Pamph. 1991), the portents for a hortatory bang fizzling into an implementing whimper are quite high. What is provided by way of institutional implementation is a charge to the already harassed and overburdened EPA Administrator to develop and implement a strategy to promote source reduction. 42 U.S.C.A. § 13103(b) (West Pamph. 1991). Infirmities in its implementation are compounded by weaknesses in the vision and substantive obligations of PPA. Furthermore, what PPA institutionalizes is the operational modality of a TCA that concentrates on preventive technology and modifications of plant, together with process and procedure redesigns. An operational version of a TCA largely assumes the need for activities and products that lead to pollution, but seeks to neutralize the deleterious effects of such activities and demands. Operational TCA does not provide for a truly comprehensive approach to pollution control that can radically and strategically change the sources and demands that lead to pollution.

report of the National Research Council,[158] risk evaluation embraces two distinct and different exercises: risk assessment and risk management. Risk assessment uses objective scientific facts to define the health effects of exposure of individuals and populations to hazardous material and situations.[159] Risk management is the process of weighing policy alternatives and arriving at policy decisions.[160] Both steps could be integrated into a TCA. Risk assessment could be used to ascertain the environmental impact of fossil fuels and risk management to design comprehensive strategies to deal with such risks.

The need for risk assessment has been endorsed by a wide range of environmental policymakers[161] including a notable nongovernmental environmental organization—the Conservation Foundation.[162] It has also found favor with the EPA, which is attempting to apply the principles of risk assessment and risk management to the broad range of issues that it confronts.[163]

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158. NAT'L RES. COUNCIL, RISK ASSESSMENT IN THE FEDERAL GOVERNMENT: MANAGING THE PROCESS (1983).

159. Harry Otway, *The Perception of Technological Risk: A Psychological Perspective, in* TECHNOLOGICAL RISK 35-36 (Meinolf Dierkes et al. eds., 1980) (citing such a view in order to criticize it).

160. *Id.* at 3.

161. For example, most of the contributors to a recent symposium on risk assessment in environmental law, Barry Commoner being a notable exception, uncritically accepted that risk assessment, like dietary fiber, is good. *See* Symposium, *Risk Assessment in Environmental Law*, 14 COLUM. J. ENVTL. L. 289 (1989).

162. *See* CONSERVATION FOUND., ENVIRONMENTAL PROTECTION ACT, *supra* note 12.

163. *See* COUNCIL FOR ENVTL. QUALITY, ENVIRONMENTAL QUALITY 211-46 (1984) (Fifteenth Annual Report setting forth the theoretical framework for conducting risk assessments and applying them to risk management decisions, as conceived and practiced by EPA); *see also* EPA, UNFINISHED BUSINESS, *supra* note 151, at 1-4; EPA, REDUCING RISK, *supra* note 151.

The emphasis on such a methodology is borne out by the fact that EPA Guidelines for Carcinogen Risk Assessment provide that risk assessments must "use the most scientifically appropriate interpretation" and should be "carried out independently from considerations of the consequences of regulatory action." 51 Fed. Reg. 33,992, 33,992-3 (1986). Howard Latin perceptively observes that the EPA's present preoccupation with "good science" reflects a commitment to risk assessment grounded exclusively on the best available scientific theories even if the scientific theories lack the certainty required for valid scientific conclusions. Howard Latin, *Good Science, Bad Regulation, and Toxic Risk Assessment,* 5 YALE J. ON REG. 89, 89-90 (1988).

Risk assessment as used in a TCA requires an analysis of all energy sources and paths. The two energy paths, described as "hard" and "soft"[164] or "renewable" and "nonrenewable," have been seen as mutually exclusive.[165] Whether this is the case is not important for this article. The way forward is not to begin with any *ex hypothesi* paradigm but to apply TCA in order to determine the path or paths to be taken. When applied to the causes of global warming—found in the production, distribution, and use of our energy—the evaluative process begins with an environmental impact analysis, proceeds to a comparison of possible alternatives, and arrives at the best option. A TCA does not postulate any *a priori* hypotheses whether based on "hard" or "soft" energy paths.[166] What is envisioned is an objective evaluation of the environmental impacts of each option, and an arrival at the most efficacious policy choice based on that evaluation.

VII. CONCLUSION

The convergence of the military and energy crises evidenced by the Gulf War and the environmental crisis evidenced by global warming come at a pivotal moment in history. The Gulf War demonstrated the importance of energy security. A critical implication is that we must look beyond fossil fuels toward other energy sources. Simultaneously, the search for environmental security in the face of global warming reinforces the need to overcome our addiction to fossil fuels. Problems that place nations and people in a common quandary call for common answers. Answers that integrate solutions to problems of both energy and environmental security are not merely prudent, but vital. Any remaining doubts about the urgency for a radical reappraisal of our energy policies have been dispelled.

The United States enjoys unparalleled geopolitical authority. Almost incontrovertibly, it is the preeminent nation in the world. Undoubtedly, it is the only country with the military, diplomatic, political, and economic assets enabling it to become a decisive player in conflicts anywhere in the world.[167] From this exalted position the United States has called for a "new world order." Such a vision will be tragically distorted unless it rests on a tripod of military, energy, and *environmental* security.

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164. Lovins, *Energy Strategy*, *supra* note 118, at 77.

165. *Id.* at 65.

166. It is perfectly possible that a "soft" energy option can result in environmental impacts as onerous as that of a "hard" one.

167. Charles Krauthammer, *The Unipolar Moment*, FOREIGN AFF., Feb. 1991, at 23, 24.

In premising the case for a TCA on the need for environmental and energy security, this article does not ignore the import of switching from carbon-based fuels. The twentieth century has witnessed every index of good living taking off for the stratosphere. By any historical assessment our unprecedented material abundance remains stunningly superior to what prevailed a mere half century ago. The common people—every man and woman—enjoy a life-style surpassing that previously enjoyed by a conspicuously narrow band of rich people. We need only compare our material possessions and opulence—the veritable feast of foodstuffs and raw materials, dramatically improving health standards, luxurious housing, transport, entertainment, and leisure—with fabled lifestyles of the mythical rich in fairy tales to appreciate the extent to which we are surrounded by unparalleled affluence. The argument that inexpensive, abundant, and accessible energy constitutes the primary reason for our prosperity[168] is difficult to resist.

This article recognizes that the sources of energy pollution also might be the sources of our prosperity. By turning away from these sources we may be shutting the wellsprings of our economic and social well-being. At the same time, we are compelled to take cognizance of the serious charge that the sources are poisoned. Unless we are reconciled to a Faustian epilogue, we need to take account of the impact and costs of our prosperity in order to plot our future. The costs of fossil fuels, including their true environmental and economic costs, the costs of energy security, and costs to future generations need to be taken into account. So too must the soft energy paths hitherto largely ignored. By taking strategic measure of all costs and options, a TCA allows us to make informed and responsible decisions about the future. In fact, it seems evident that the environmental and economic arguments upon which the United States premises its so-called "comprehensive approach" founder in the face of a TCA.

Finally, it behooves us to take account of an important reason for the skewered path taken by negotiations for a global warming treaty. It lies in the absence of satisfactory national laws and policies dealing with global warming. The global warming negotiating process confirms the thesis that in matters critically affecting nations, international law-making cannot be divorced from national law-making.[169] Changes in national laws and policies dealing with global warming are a vital step in the creation of international laws and standards. Among the nations of the world, the

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168. *See* WARD & DUBOS, *supra* note 62, at 10.

169. Lakshman D. Guruswamy, *Global Warming: Integrating United States and International Law*, 32 ARIZ. L. REV. 221, 253-67 (1990).

United States is the leading contributor to GHGs. With five percent of the world's population the United States accounts for twenty-one percent of global warming,[170] and almost alone among the industrial nations has opposed treaty provisions obligating specified emissions reductions. Attempts at limiting global warming should begin with the United States.

When faced with the likelihood of a new Soviet threat giving rise to global insecurity in the aftermath of the Second World War, the Western powers agreed that a credible defense of Western Europe was necessary. Although the Western powers disagreed on how to execute that commitment, they concurred on the need for action to avert the threat to security.[171] Despite the easing of tensions, the need for massive expenditure on military preparation to meet a potential threat has continued to be the conceptual linchpin of defense policies. Analysts who were convinced of the necessity to incur enormous expenses to guard against a potential Soviet attack can hardly demand a more onerous standard of proof from those seeking action against the potentially irrevocable and devastating impacts of global warming.

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170. EPA POLICY OPTIONS, *supra* note 25, at 148.

171. This is an almost obvious point. For an historical survey, see David N. Schwartz, *A Historical Perspective, in* ALLIANCE SECURITY: NATO AND THE NO-FIRST-USE QUESTION 5, 5-9 (John D. Steinbruner & Leon V. Sigal eds., 1983).