Prescriptive Treaties in Global Warming: Applying the Factors Leading to the Montreal Protocol

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Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.¹

In the developing countries most of the environmental problems are caused by under-development. Millions continue to live far below the minimum levels required for a decent human existence, deprived of adequate food and clothing, shelter and education, health and sanitation. Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. For the same purpose, the industrialized countries should make efforts to reduce the gap [between] themselves and the developing countries. In the industrialized countries, environmental problems are generally related to industrialization and technological development.²

The international community has long recognized that environmental problems can reach beyond territorial borders to affect the entire globe. Problems such as transboundary pollution, ozone depletion, and climatic change know no political or cultural boundaries and often cannot be solved by individual nation-states.³ The global community has also recognized that environmental problems often manifest long before the scientific community can conclusively point to a cause. Despite the words of the precautionary principle in the Rio Declaration on Environment and Development,⁴ the global community has not effectively acted to resolve the serious transboundary environmental problem known as global warming.

One of the main problems in resolving global warming is convincing developing nations that they can reduce their emissions without compromising their economic growth. As the Stockholm Declaration hints,⁵ developing nations want to continue down the same path developed countries took to industrialize, even if it negatively affects the

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⁴ Rio Declaration, supra note 1.

⁵ Stockholm Declaration, supra note 2.
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environment. Many of the developing nations rightfully claim that developed nations exploited the environment to make their economic strides. Yet developed nations now are unwilling for developing nations to take similar steps.

The only prescriptive environmental agreement that successfully overcome similar problems is the Montreal Protocol. The key to its success was the effective negotiation and implementation of a technology transfer and financing provision. While several other international agreements have similar provisions, none have been implemented as successfully as the Montreal Protocol.

In order to combat the ever-increasing problem of global warming, developing nations need technology that will limit emissions while allowing for economic growth. This paper will first examine the problem of global warming. In Part II, the paper will explore the reasons developing nations currently are unable to reduce their emissions. In Part III, the paper will look at the factors leading to the success of the Montreal Protocol and examine the global warming debate in light of these factors.

I. THE REALITY OF GLOBAL WARMING

A. The Cause of Global Warming

The greenhouse effect received its moniker because certain gases, when they are in the atmosphere, create a greenhouse around the planet. Greenhouse gases absorb and reradiate to the planet’s surface the heat radiation that usually leaves the planet. The amount of greenhouse gases in the atmosphere determines the amount of radiation that remains near the Earth, which determines the temperature of the planet. When greenhouse gases are increased by human activity, the result is an increased heating of the planet.

While several gases and particulates can affect the temperature of the Earth, the main greenhouse gases are water vapor, carbon dioxide,
ozone, methane, and nitrous oxide.\textsuperscript{10} The primary greenhouse gas is carbon dioxide, which is responsible for sixty percent of the greenhouse effect.\textsuperscript{11} In the ten thousand years prior to industrialization, carbon dioxide levels varied by less than ten percent.\textsuperscript{12} However, carbon dioxide levels have risen thirty five to forty percent since the middle of the nineteenth century.\textsuperscript{13} Thirty percent of that rise has occurred in the last century alone.\textsuperscript{14} The concentration of carbon dioxide, and the greenhouse gas methane is now higher than at any time over the past four hundred twenty thousand years.\textsuperscript{15}

Most scientists agree that the primary cause of global warming is the burning of fossil fuels, including coal, oil, and gas.\textsuperscript{16} A second major source of carbon dioxide emissions is the clearing of land, including tropical forest, for agricultural use.\textsuperscript{17} Deforestation increases emissions in two ways. First, trees are a "carbon sink," a natural feedback mechanism that absorbs carbon dioxide from the air.\textsuperscript{18} When trees are cut, less carbon dioxide is removed from the air.\textsuperscript{19} The decrease in carbon sinks can significantly add to global warming since, even with the existing carbon sinks absorbing half of humanity's carbon dioxide emissions, atmospheric levels continue to rise by more than ten percent every twenty years.\textsuperscript{20} Second, when trees are cut down, they release the stored
carbon dioxide.21 Recent estimates note that deforestation may release as much as 2.8 million metric tons of carbon dioxide per year.22

The human effects on the climate system variations now dominate natural forces.23 Not only do humans add enormous amounts of carbon dioxide and other greenhouse gases to the air, but we also decrease carbon sinks, which nature has used to keep the naturally occurring greenhouse gases in balance with the Earth’s needs. Since carbon dioxide, once in the atmosphere, has a half-life of approximately seventy years,24 excessive carbon dioxide is not a problem that lends itself to an easy or quick solution.

For the most part, the major sources of greenhouse gas emissions have been industrially developed countries.25 Because developed nations caused a large portion of the existing pollution, many developing countries believe that the burden of emissions reductions should be placed solely upon developed countries.26 However, as Bartenstein, a spokesman for the European Union, stated in 1998, “industrialized countries will have to take the lead. There’s no doubt about it. But there will be a time coming when it will have to be a global effort.”27 That time may be now. By 2020, currently industrializing countries such as China, India, and Brazil will surpass the industrialized countries in total emissions.28 Collectively, the emissions of the developing world are already outpacing those of the developed countries.29

Without the full cooperation of developing countries, the world will continue on its present course of overheating.30 For example, China has taken several steps to decrease emissions while developing their economic power.31 Despite these steps, China is listed as one of the largest

21. Id.
22. Id.
26. For example, the Chinese Government in 1992 called on the developed countries to pay more than $125 billion of the estimated $600 billion needed by developing countries for environmental clean up. Jan Wong, Beijing Wants Rich to Help Pay, GLOBE AND MAIL, June 2, 1992, at A3.
28. Brady Coleman, Less Hot Air, More Concrete Results, THE STRAITS TIMES, OCT. 24, 1999, at 33 (lecturer at the Faculty of Law of the National University of Singapore and member of the Executive Committee of the Asia Pacific Centre for Environmental Law).
29. Gattuso, supra note 25, at 6A.
30. Id.
31. Panjabi, supra note 6, at 520 n.195.
polluters due to their rapid industrialization. "As the Chinese example demonstrates, the world cannot afford the luxury of African, Asian, and Latin American development at its present pace without paying a very heavy environmental price in the not-too-distant future."

B. The Effects of Global Warming

In the past, scientists have disagreed about the possible effects of global warming on the world. However, new and more sophisticated studies in recent years have bolstered prior pessimistic predictions regarding the effects of warming. Some projections of global temperatures predict an increase of two to six and one half degrees Fahrenheit over the next one hundred years, but the most recent and reliable projections by an international panel of experts predict that global temperatures could rise by an average of 6.3 degrees Fahrenheit. Inland regions will warm faster than coastal zones, with the greatest warming predicted for northern regions during winter. By 2100, parts of northern Canada and Siberia could warm by ten degrees in winter and two degrees in summer. These massive temperature changes will lead to a number of disaster scenarios, including sea level rise, flooding and droughts, and the spread of deadly disease.

1. Sea Level Rise

The rise in temperature will significantly impact the sea level. The mean sea level already has risen between ten cm and twenty five cm in the last one hundred years. Much of this increase probably is related to a .3 to .6 degree increase in the lower atmosphere’s average temperature since 1860. In the next one hundred years, scientific models project a foot and a half rise in sea levels. This predicted rise will be two to five times faster than the rise experienced over the past century.

32. Id.
33. Id.
34. Id. at 495 n.19.
36. Lane, supra note 14. These projections take into account all the uncertainties based on disagreements over the feedback effects and are based on more accurate scientific data and models than any prior research. Id.
37. Knight, supra note 16.
39. Id.
40. Id.
41. Id.
43. Id.
Temperature increases cause sea levels to rise in two different ways. First, warming expands ocean water. One estimate is that about twenty percent of the heat from global warming is absorbed by the oceans. The increased temperature causes expansion of the ocean water. Second, the increased temperature will cause a partial melting of the polar icecaps. In fact, recent studies show that the great ice cover that stretches across the top of the globe is already approximately forty percent thinner than it was only a few decades ago. Additionally, a recent voyage to Antarctica confirmed a massive glacial melting. As the glaciers continue to melt, the Arctic ice sheet is at greater risk of melting. Experts state that if even a part of the Arctic ice sheet melts, sea levels will significantly rise around the world.

The effect of a sea level rise will be immense. Tens of millions of people who live in small island states and low-lying deltaic areas will be displaced. It is not only small island states that will suffer. Large nations will lose substantial portions of their landmass as well. For example, Bangladesh could see its land area shrink by seventeen percent, displacing millions of people and placing greater pressure upon the remaining land.

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44. Lane, supra note 14.
46. Id.
48. Kerry, supra note 24. This statistic is based on a study from University of Washington scientists. Id. They found that the rate of thinning in the 1990s is approximately 4 inches a year. Id.
49. Geoffrey Lean, *Antarctica “Melting Before Our Eyes”, INDEPENDENT ON SUNDAY*, Feb. 11, 2001, at 10; see also Trenberth, supra note 45. “The explorer and yachtsman Sir Peter Blake called the ministers attending the governing council of the United Nations Environment Programme to say that he had just sailed 100 miles through open water that had been frozen for hundreds of thousands of years. The King George VI ice shelf at the base of the Antarctic peninsula was breaking up, he said.” Lean, supra, at 10. “Sir Peter said: ‘I am speaking from an area of water that has never been water before. It has always been frozen solid. It is uncharted. There are no depth readings on the map because no ship has ever been able to measure them. No one has ever been anywhere near where we are now.’” Id.
50. Kerry, supra note 24.
2. Flooding and Droughts

Global warming will also increase flooding while, paradoxically, causing droughts in other places. "Rising temperatures will increase rates of evaporation and lead to more total precipitation."\(^5\) When there is increased moisture in the air, the added moisture increases the size and severity of storms.\(^3\) The increased severity of storms causes increased rainfall rates, which result in flooding.\(^5\) Experts predict that, in twenty years' time, five billion people will be vulnerable to flooding; that amounts to seventy percent of the world's population.\(^6\)

Simultaneously, global warming will cause others to suffer from lack of water. When moisture levels increase in one part of a weather system, inevitably there will be drying in other parts of the system.\(^5\) Rainfall will become scarcer in the midlatitudes, where most developing countries are located.\(^5\) Currently, the existing temperature increase has placed millions in danger. The Christian Aid Report found that one hundred million people are at risk in India and sixteen million people face starvation in Ethiopia and the Sudan because the rains have failed for three years running.\(^5\) Global warming will cause the arid and semi-arid areas of Africa, the Middle East, and Southern Europe to become even more water-stressed than at present.\(^6\)

The lack of water will impact the ability of people from these regions to feed themselves in the years ahead.\(^6\) Predictions estimate that agricultural production in Africa and Latin America could decrease ten to thirty percent.\(^6\) At the same time, the drought will also affect wetland areas, a carbon dioxide sink that contains as much greenhouse gas as is contained in the atmosphere.\(^6\) Droughts caused by global warming could drain these areas and trigger a release of thousands of years of stored carbon dioxide, multiplying the greenhouse effect.\(^6\)

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55. *Id.*
57. Trenberth, *supra* note 45.
59. Ingham, *supra* note 56. The UN weather agency also announced that heat deaths are expected to double in the next twenty years if nothing is done to slow or stop global warming. *Disgrace at the Hague,* THE PROGRESSIVE, Jan. 1, 2001, at 8.
60. Watson, *supra* note 51.
63. Global Warming: Why Time is Running Short, INSURANCE DAY, Jan. 16, 2001, at 4 (based upon 10 years of study by Dr. Chris Freeman from the University of Wales).
64. *Id.*
3. Effects on Economy

Every nation bases their economy and way of life on certain expectations regarding climate. However, global warming is associated with variations in rainfall and snowfall, increased frequency of floods and droughts, El Niño or La Niña events, and shifts in storm tracts and hurricanes. Additionally, the melting ice changes ocean currents, which can alter the climate anywhere or everywhere on the planet in unpredictable ways. “Much of our infrastructure for water supply, agriculture, and transportation was built on the assumption that climate would continue to operate in the future . . . as it has in the past.” Because of the significant and unpredictable climatic changes, the assumptions regarding infrastructure will no longer be true. When associated with the atmospheric circulation, a small shift in average hemispheric temperatures can be highly disruptive to society.

The costs associated with global warming will have a devastating effect on the world economy. Globally, the cost of climate-related natural disasters have doubled every decade. In the 1960s, 16 natural disasters occurred and cost fifty billion dollars. In the 1990s, 70 natural disasters occurred and cost four hundred billion dollars. At our current pace, a recent UN Environment Program report predicts that, in 50 years, global warming will cost the world more than three hundred billion dollars annually. The insurance companies concur. They predict that the cost of natural disasters after global warming may be greater than the global gross domestic product by 2065, bankrupting the world economy.

4. Diseases

An indirect effect of rising temperatures is an increase in spread of vector-born diseases, such as malaria and dengue. Currently, forty five percent of the world’s population live in areas where mosquitoes

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66. Id.
68. Bradley, supra note 13.
69. Id.
70. Frank McDonald, Making the Poor Pay, THE IRISH TIMES, Dec. 28, 2000, at 50.
71. Id.
72. Id.
74. McDonald, supra note 70, at 50.
75. Watson, supra note 51.
transmit malaria. As the temperature rises, the incidents of vector-borne diseases will increase significantly in the tropical countries where malaria already exists. Additionally, an increase in temperature would change the temperate zones into more tropical climates, triggering a northward spread of malaria. Models predict that the malaria zone will grow to encompass the land where sixty percent of the world’s population live. This increase in the malaria zone will lead to as many as eighty million more cases of malaria per year.

5. Cumulative Effect

The world is already feeling the effects of global warming. The problems include eroding coastlines, increasingly salty soil that poison crops, threats to burial sites near coasts and in caves, changes in weather patterns and fisheries, and devastating droughts. Two scenarios present the greatest danger to the world: an accumulation of disasters and a suddenly triggered, abrupt climate change. The Christian Aid Report finds a “spiral of catastrophe” to be a strong possibility if nothing is done to stop global warming.

Millions face death over the next 20 years from a “spiral of catastrophe” caused by global warming, a shock report warns today. It predicts a ninefold increase in climate-related disasters in the space of a decade compared with the 1960s. By 2020, the world will have seen another 245 major disasters like the Mozambique floods or the Ethiopian famines.

The problem highlighted in this report is not the increased number of storms, floods, or other individual events. The spiral of catastrophe is the accumulated effect of numerous severe climatic disasters.

In addition to this spiral, some scientists have postulated that our ever-rising temperatures will trigger an abrupt climate change. When examining Greenland ice cores in 1999, scientists found signs that the ice age,

76. Clarkson, supra note 10, at 4.
77. Id.
78. Watson, supra note 51.
79. Knight, supra note 16.
81. Id.
82. Yves Leers, Poorer Nations Should Not be Climate Debate Scapegoats, AGENCE FRANCE PRESSE, Nov. 4, 1998 (quoting the South Pacific Forum regarding the experiences their countries have).
83. Ingham, supra note 56.
84. Id.
which gripped the Earth for thousands of years, ended abruptly when temperatures soared for two decades. The Earth will warm significantly in the next one hundred years due to the greenhouse effect caused by gases already in the atmosphere. Scientists fear the possibility, a remote but plausible one, that significant warming over the next century may trigger one of these abrupt climate changes. The effect of such a change could be cataclysmic.

As Dr. Lane stated in 2000 to the Senate Commerce, Science, and Transportation Committee, the National Academy of Science's report "made it very clear that there really is not any remaining debate about whether the earth is warming or not. It is quite clear that the earth is warming, and there is significant consensus that the human activity is a part of that warming." The scientific evidence has even convinced some energy and utility stalwarts, such as American Electric Power Company, that human-caused global warming is occurring. Most experts believe that developing nations will bear a disproportionate share of the harms from climate change, no matter who caused the damage. Despite that fact, developing nations have not indicated a willingness to cooperate internationally.

85. Sohn, supra note 11, at A1.
86. Id. (quoting Jeffrey P. Severinghaus of the Scripps Institution of Oceanography).
87. Id.
88. Lane, supra note 14.
89. John Carey, Look Who's Thawing on Global Warming, BUSINESS WEEK, NOV. 9, 1998, at 103. In fact, eighteen companies are involved in the Pew Center on Global Climate Change, formed by thirteen companies, to search for ways to prevent global warming. Id.
91. Michaelson, supra note 90, at 96.

For example, in an emissions-reductions-only world, China is an absolutely essential "problem" player: even if every other nation froze its GHG emissions, world emissions would rise forty percent if China raised per capita emissions to half of U.S. levels. Yet, historically, China has responded in a generally hostile manner towards claims of international law and comity, and more recently, developing nations-led by China, India, and Brazil-have demanded a "pass" at Kyoto, arguing that developed nations should reduce first.

Id. (internal citations omitted).
II. THE REASONS DEVELOPING COUNTRIES DO NOT REDUCE EMISSIONS

It is not that developing countries are unwilling to reduce emissions at all. A report released by the National Environmental Trust suggests that many developing countries have begun limiting their greenhouse gas emissions as of 1998.\(^\text{92}\) These developing nations are reducing emissions despite their lack of technological and capital advantages when compared to developed countries.\(^\text{93}\) At the Kyoto Conference many developing countries indicated a willingness to agree to a voluntary commitment to set targets and timetables for curbing emissions.\(^\text{94}\) However, when the developed world agreed to voluntary commitments at the Rio Conference, these targets were completely ineffective in reducing global emissions. Consequently, mandatory reductions are necessary to reduce greenhouse gas emissions. Unfortunately, developing nations still espouse a strong distrust of mandatory reduction measures.\(^\text{95}\)

Three main factors cause this unwillingness to commit to binding reductions on the part of developing countries. First, the developing world desires the economic growth that developed nations achieved through ecologically destructive practices. Second and related to the first factor, developing countries are suspicious of requests from the developed world for binding protections. They fear that these environmental provisions are simply a disguise for protectionist measures. Third, despite the fact that they are reducing some emissions, most developing countries simply do not possess the necessary technology to reduce their emissions effectively while maintaining economic growth.

A. Economic Growth

Many developing nations, despite their weaker economies, are already engaging in environmental protections. They recognize that sustainable development and environmental protection is the ideal for a just world economic order.\(^\text{96}\) However, since economic growth is their priority, developing nations are unwilling to bind themselves to commitments that might compromise that growth.

Developing nations have enormous internal pressure to place environmental concerns second to the economic growth garnered through

\(^{92}\) Knight, supra note 16.

\(^{93}\) Id.

\(^{94}\) Knickerbocker, supra note 27, at 7.

\(^{95}\) Panjabi, supra note 6, at 514 n.167; Knight, supra note 16.

attracting foreign investment. Indeed, it is the low level of natural resources combined with the high priority placed on economic growth that often cause developing nations either to lower or never implement environmental protections in order to attract foreign investors. Currently, developing nations' best opportunity for economic growth is from foreign investment. Transnational corporations (TNCs) engage in foreign direct investment (FDI) when conducting business in a foreign country gives the corporations technological or economic advantages over their competitors. One technique employed by developing countries to attract the attention of TNCs is to lower operational costs, often achieved by lower environmental standards. Not only are these nations concerned that higher environmental standards will increase capital and operating costs and diminish competitiveness, but they also fear that full recognition of environmental rights will divert existing aid from ongoing development projections and will shift the TNC development to other developing countries that have lower costs. Although many of these nations have long since recognized that they have serious domestic environmental problems, they feel compelled to focus on their urgent, unmet economic and social needs first.

A perfect example of a developing nation in this position is China. Currently, China emits more than thirteen percent of global carbon dioxide emissions. China is second in emissions only to the United States and, at its current rate of economic development, will surpass the United States in carbon dioxide emissions by 2020. Although these numbers seem to indicate otherwise, China has actually been on a veritable emissions crusade. “China has sharply reduced subsidies for coal and has improved energy efficiency in its industrial sector by

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97. Alberts, supra note 96, at 64.
100. Id. at 574 n.37.
101. Scott Vaughan, Trade and Environment: Some North-South Considerations, 27 CORNELL INT’L L.J. 591, 597 (1994). Although these concerns have surfaced periodically since the 1970s, several studies show that increased environmental expenditures often improve overall economic performance. Id. at n.24.
102. See McClymonds, supra note 3, at 607.
103. Alberts, supra note 96, at 64.
104. Speth, supra note 52, at A9.
105. Id.
106. Gao Feng, deputy director of the Treaty and Law Department of China’s Foreign Ministry, stated that “China, nonetheless, is working to reduce its carbon dioxide emissions by including more power plants fueled by natural gas, water or nuclear energy.” Craig S. Smith, Global Warming Debate Heats Up in Shanghai, INTERNATIONAL HERALD TRIBUNE, Jan. 19, 2001, at 4.
modernizing or closing down highly polluting enterprises." Without such steps, China's emissions of carbon dioxide would be fifty percent higher today than it is.  

Despite China's steps to reduce greenhouse gas emission, the Chinese delegate in Kyoto stated "it is not possible for the Chinese government to undertake the obligation of reducing greenhouse gases until China works itself out of Third World poverty." Zeng Peiyan, the Minister of State Development Planning Commission in China, concurred by stating that "poorer countries are unable to undertake the duty of cutting gas emissions, though they have come to realize the significance of sustainable development." While climate problems concern China, they are unable to make the desired contributions in addressing climatic changes because "economic development and poverty eradication must top the agenda of the Chinese Government." As with many other developing nations, China will do what it can to help the environment without sacrificing any economic development, which means that China will continue to reject binding commitments to reduce.

Developing nations are so named because they still do not possess the solid economic position that several other nations, such as the United States, possess. These nations, of course, do not wish to destroy their environment. However, most developing nations are under tremendous internal pressure to raise economic standards. Despite a growing awareness of the relation between economic and environmental issues, developing countries will continue stressing the right to development as more important than the right to a healthy environment, and, therefore, they will not commit to binding emissions controls without some economic incentive.

B. Distrust of the Developed World

In conjunction with a tremendous desire for economic growth, developing countries distrust environmental proposals from developed nations. Developing nations cite two reasons why they should not have to reduce their emissions. First, the developed nations exploited their natural resources and destroyed the environment to achieve their high economic development. Developing nations want the same opportunities

107. Id.
108. Id.
111. Id.
112. Alberts, supra note 96, at 64.
113. See McClymonds, supra note 3, at 607.
as their predecessors. Second, developing nations fear that environmental protection measures associated with trade measures contain a hidden agenda of economic protectionism.

In order to achieve the level of economic development that they currently have, developed nations exploited their own natural resources and, when those were exhausted, the natural resources of developing countries. Many developing nations now feel that they are required to bear the costs of pollution when they neither created the pollution nor benefited from the resulting economic development. This argument assumes, of course, that the environmental policies will cause economic hardship for developing countries, preventing them from achieving economic growth.

Developing nations also distrust environmental initiatives instigated by developed nations when the proposals integrate environmental issues with trade. Developing countries see such measures as reflective of developed countries priorities while ignoring the priorities of developing nations. By attempting to implement environmental measures within a trade context, such as GATT, many developing countries fear that the environmental considerations are disguised protectionist measures. Given the threat these measures potentially pose to the important economic benefits developing countries expect from trade liberalization, developing countries view any proposal to amend trade rules to accommodate developed country environmental priorities with considerable caution.

C. Lack of the Technology to Decrease Emissions

As with their economy, developing countries often wish that they had the ability to cultivate technology domestically. Unfortunately, most developing nations still lack the capital resources and personnel to...
internally develop technology. Consequently, developing countries rely on technology transfer as the main, and sometimes the only, means of obtaining new technology. Especially in technologically new areas such as emission control, developing countries are unable to create the technology themselves.

Technology alone would not be useful without also having knowledge of how to implement and utilize the technology appropriately. To that end, the United Nations uses a very broad definition of technology in relation to technology transfers, which includes a combination of equipment and knowledge. Equipment is defined as including tools, vehicles, machinery, buildings, and process technology. Technological knowledge is considered to be franchise methodology, conventional technology, know-how, and high technology. The term technology transfer itself does not have a clear definition but must include effective absorption of the transferred technology by the recipient country.

Currently, two forms of “joint implementation” should give developing nations an opportunity to receive new technology: transfers from TNCs and transfers from developed nations. In the context of global warming technology, “joint implementation” generally means that entities in developed countries undertake GHG emissions limitations in developing countries at costs lower than they would incur were those limitations implemented at home.

Neither form of joint implementation has been effective in the global warming context. Technology transfers from TNCs have greatly dissatisfied developing nations. Technology is usually created for developed countries and then sold to the developing countries in “packages”. This technology often is not suited for the developing country, but exporters do not feel that it is worth the effort to adapt the technology for the developing nations since they are small technology markets and offer limited profit-making opportunities. These “packages” of technology increase the direct and indirect costs of technology.

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120. Id. at 573.
121. Id.
123. Id. at n.6.
124. Id. at n.5.
125. Id. at 211–12.
127. Alberts, supra note 96, at 69.
128. Haug, supra note 122, at 224.
129. Id.
for the developing countries and do not aid developing nations in creating their own technology.\textsuperscript{130} The other common method is a joint implementation with developed nations. Although one of joint implementation’s equitable side benefits is technology transfer, developing countries point out that such technology transfers often do not occur.\textsuperscript{131}

Even when the developing nations receive the technology, they often lack the technology infrastructure necessary to implement the technology effectively.\textsuperscript{132} “These support systems include hardware, technological education, the level of process technologies in the receiving firms, the capability to perform research and development work, and the ability to maintain technology and organizational infrastructures.”\textsuperscript{133} When these missing support systems are combined with the lack of skilled labor in many developing nations, those countries face significant impediments to successful industrial development.\textsuperscript{134}

Regardless of the past difficulties with joint implementation for emissions reduction, a successful technology transfer program will address the majority of concerns that developing nations have. Obviously, successful technology transfers will solve the technological deficit that developing nations face when trying to reduce emissions. Technology transfers also will allow reduction of developing countries’ emissions without requiring additional economic expenditures. Therefore, developing countries can continue their economic growth while reducing emissions. Moreover, the developing countries’ distrust for environmental measures cannot survive in the face of government-sponsored technology transfers because this type of joint implementation cannot include a protectionist motive. Even though both TNC and government joint implementations have failed in the global warming context, governmental joint implementations have been successful in other contexts.\textsuperscript{135} The remainder of this paper will examine the factors that have lead to successful joint implement in the Montreal Protocol, which concerned a global crisis related to atmospheric pollution, and will apply these factors to the current global warming debate in order to evaluate whether the global warming issue is ripe for successful governmental joint implementation.

\textsuperscript{130} Id. at 224, 225; Alberts, supra note 96, at 69.
\textsuperscript{131} Martin Khor, \textit{North Stalls Eco-Friendly Technology Transfers}, \textsc{Global Info. Network}, Aug. 19, 1996. The Montreal Protocol, however, was a successful technology transfer. See infra Part III.
\textsuperscript{132} Haug, supra note 122, at 223.
\textsuperscript{133} Id.
\textsuperscript{134} Id.
\textsuperscript{135} \textsc{Infra} Part IIIA.
III. Obtaining Technology Transfers to Reduce Emissions

Most scientists have said that technology will be the only way to combat global warming although some scientists have hypothesized that we can control global warming by effectively using carbon sinks. However, even accounting for all possible types of reasonable land use changes and other natural processes, the enormous increases in carbon dioxide projected for the next few decades will far out pace any positive natural feedback mechanisms. The key to reducing the carbon dioxide emissions will be technology.

As Zeng Peiyan, Minister of State Development Planning Commission in China stated, "developed countries have the technology and capital to deal with climate changes, while many developing countries are still afflicted with poverty. Poorer countries are unable to undertake the duty of cutting gas emission, though they have come to realize the significance of sustainable development." Yet, China, as one of the strongest economies among the developing nations, has begun the process of reducing its emissions, and it has done so by introducing more efficient technologies, indicating that the most successful option to combat global warming in developing countries is technology transfer.

Since the beginning of the environmental movement in the United Nations, resolutions have included provisions for technology transfer. The Stockholm Declaration includes technology transfer provisions in two principles, a general provision and one specific to ecological disasters. Moreover, the Rio Declaration and the subsequent Agenda 21

136. See generally McCarthy, supra note 14.
137. See, e.g., Rob Drent, Emission Tax on Cards as Plan Fails, THE SUNDAY STAR-TIMES (AUCKLAND), April 28, 1996, at 4 (discussing the complete failure of New Zealand's plan to meet carbon emission targets mostly through forests sinks).
138. CHINA DAILY, supra note 110; see also Smith, supra note 106.
139. Knight, supra note 16.
140. For example, the 1962 Resolution on Permanent Sovereignty Over Natural Resources includes a technology transfer provision.

International co-operation for the economic development of developing countries, whether in the form of public or private capital investments, exchange of goods and services, technical assistance, or exchange of scientific information, shall be such as to further their independent national development and shall be based upon respect for their sovereignty over their natural wealth and resources.

141. Stockholm Declaration, supra note 2, prins. 9, 12.

Resources should be made available to preserve and improve the environment, taking into account the circumstances and particular requirements of developing
also state that developed countries should transfer technology as well as scientific or technological knowledge in the specific context of sustainable development.142

However, these technology transfer provisions have not been used to respond to any specific environmental problems. Instead, a number of environmental provisions have been inserted into proposed trade measures. Developing nations fear that these environmental measures simply protect the global economic dominance of the developed nations.143 Despite such resistance, the developing nations want assistance from the industrialized world in the form of energy-efficient, clean technologies.144 Developing countries remain deeply wary of the so-called "greening" of trade rules while giving strong approval to provisions that contain commitments from developed countries to provide tangible assistance through additional financing, technology transfer, increased commitments to overseas development assistance, and other sustainable development initiatives.145 For example, resistance to environmental measures was temporarily surmounted at the Rio Conference when developed countries committed to provide tangible assistance to developing countries.146

Most past attempts by the United Nations to aid in effective technology transfer in general have failed.147 For example, negotiations concerning the New International Economic Order (NIEO), an attempt

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143. Supra note 117 and accompanying text.

144. Carey, supra note 89, at 104.


146. Id. at 597.

147. Some have argued that the lack of success in technology transfers lies in part on the lack of effective patent protection in many countries. Kwon, supra note 99, 568 n.3. Thailand changed its patent protections based on that assumption. Id. However, empirical studies have found that developing countries with the highest level of foreign direct investment are also the countries with the worst intellectual property rights. Frederick M. Abbott, The New Global Technology Regime: The WTO TRIPS Agreement and Global Economic Development, 72 CHI.-KENT. L. REV. 385, 390 (1996). Developing countries that lack economic attractiveness but have stronger intellectual property rights protections do not attract higher levels of investment compared to other similarly situated countries. Id. at 390–91.
to “level” the international economic playing field, faltered during the
debt crisis of the early 1980s. In the environmental framework, the
Rio Conference was successful in shaping and linking the international
values of equity and environment in the context of the relationship be-
tween developed and developing nations. However, the Rio
Conference failed to reconcile conflicting goals, and its greatest accom-
plishment is not said to be the actual commitments. In contrast to
these two examples, the Montreal Protocol is an example of a very suc-
cessful prophylactic environmental policy that includes technology
transfer.

A. The Montreal Protocol

Usually, international treaties that attempt to “leapfrog” the develop-
ment-environment sequence by placing environmental priorities
ahead of development gains are rejected or viewed as part of developed
country obligations to assist developing countries. Prior to the Mont-
real Protocol, technology transfer and financing clauses were written
into several conventions without successful implementation. However,
the Montreal Protocol successfully overcome these problems and
changed the development-environment sequence. It is the first pre-
scriptive multilateral agreement to be ratified on an international level
successfully. In other words, this is the first agreement where nations
took a concerted international effort to minimize an environmental risk,
rather than simply responding to an existing environmental disaster.

Representatives of virtually all-significant producers and consumers
of ozone-depleting substances signed the Montreal Protocol in Septem-
ber 1987. It requires parties to take “every practicable step” to ensure

148. Thomas, supra note 98, at 2106, 2108. The Programme of Action on the Transfer
of Technology in NIEO provided for the formulation of an “international code of conduct for
the transfer of technology corresponding to needs and conditions prevalent in developing
countries,” “access on improved terms to modern technology,” and the adaptation of “com-
mercial practices governing transfer of technology” to the requirements of the developing
countries. Id. at 2107.

149. David A. Wirth, The Rio Declaration on Environment and Development: Two Steps
Forward and One Back, or Vice Versa?, 29 GA. L. REV. 599, 609 n.27, n.28 (Spring 1995).

150. Id.

151. Vaughan, supra note 101, at 603–04.

152. McClymonds, supra note 3, at 623.

153. Id. at 623 n.44.

154. A. Dan Tarlock, The Role of Non-Governmental Organizations in the Development

155. Id.; Thomas, supra note 98, at 2106, 2104.

156. Clare Langley-Hawthorne, An International Market for Transferable Gas Emission
Permits to Promote Climate Change, 9 FORDHAM ENVTL. L.J. 261, 279 (1998).
the “expeditious” transfer of “the best available, environmentally safe substitutes and related technologies” to certain developing countries.157

Four factors combined to ensure that a technology transfer and funding clause was included and effectively implemented in the Montreal Protocol. First, the science was nearly irrefutable. Second, there was a proven need for multilateral action. Third, technology provided plausible alternatives to chlorofluorocarbons (CFCs), the main cause of ozone depletion. Finally, knowing that multilateral action was needed, the developing nations pushed for a technology transfer clause.

First, to successfully convince the international community to act on a preventative environmental issue, the science must be very clear and persuasive. The 1987 Montreal Protocol is an extremely science driven international agreement.158 In awarding the 1995 Nobel Prize for Chemistry to Sherwood Rowland and Mario Molina, “the Royal Academy of Sciences credited the scientists for providing the driving force behind the Montreal Protocol.”159 It was the scientific research that forced the international community to recognize that something needed to be done to eliminate CFCs globally.160

Second, the international community must be convinced that multilateral action is needed. Unilateral action often begins before the international community is convinced that action must be taken. For example, the original ban on CFCs in 1978 decreased emissions originating from the United States.161 Even though developing nations’ per capita consumption was very small compared to developed nations, their emissions continued to grow, and there was concern that this growth would overwhelm any reduction by the United States and

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157. Chris Wold, Multilateral Environmental Agreements and the GATT: Conflict and Resolution?, 26 ENVTL. L. 841, 903 (1996) (citing Adjustments and Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer, June 29, 1990, reprinted in 30 I.L.M. 537). Developing countries with per capita consumption of CFCs and other controlled substances below a certain level were eligible for the technology transfers. Id. at 903.

158. Tarlock, supra note 154, at 62.


Notably, although the science was certain with regard to the cause and effect of chlorofluorocarbons on the atmosphere, it was uncertain in other areas. Landers, supra note 159, at 462; Geoffrey Palmer, New Way to Make International Environmental Law, 86 A.J.I.L. 259, 274 (1992). Therefore, the original fifty percent mandatory reduction in the Montreal Protocol had to be quickly strengthened by the Helsinki Declaration and the London Amendments of 1990. Palmer, supra, at 274–75.

European Environment Programme (UNEP). Unilateral action by a few countries also exposes those countries to a competitive disadvantage in the global economy. By coupling strong science with an understanding that this is a transboundary and global issue, it became clear that multilateral action was necessary.

Third, most nations require proof that a viable alternative exists, countering concerns that an emissions reduction or ban will cause the economy to suffer. “One of the chief reasons the Montreal Protocol has been effectively implemented is the availability of alternative, ozone friendly, technologies.” The availability of ozone-safe technology provided the necessary incentive to industries to phase out CFCs and halons as well as lower the compliance costs of the protocol’s obligations. Since alternatives to CFCs were commercially viable, industrialized nations were willing to agree to the Montreal Protocol after the magnitude of the danger became clear.

Fourth, the developing nations, recognizing their position of power since multilateral action was required for an effective treaty, used their bargaining power to demand an effective technology transfer clause. Since technology transfer clauses had been unsuccessfully written into several other conventions, it is clear that the technology transfer and

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162. Id. at 285.
163. Id. at 277.
164. Id. at 285.
165. Id. at 265.
166. Id. at 285.
168. Because a global treaty was needed, the developed nations made concessions in order to have developing nations as signatories.

At the time the international community agreed to phase out several chemicals under the Montreal Protocol on Ozone Depleting Chemicals, the industrialized world used large amounts of these substances as refrigerants and industrial solvents. Developing countries were not prepared to give up the future benefit of refrigeration or domestic industries that use solvents, benefits long enjoyed by developed countries. So the developed countries agreed to lead the effort to solve the environmental problem they caused by phasing out several ozone-depleting substances during the Montreal Protocol’s first decade. They also agreed to a program of developing and transferring new technology to make it possible for less developed countries to enjoy refrigeration and increased manufacturing capability without relying on ozone-depleting chemicals. Developing countries agreed to a late phaseout because they believed that developed countries would develop adequate substitutes as they eliminated their own consumption of ozone depleters. Accordingly, developing countries could help solve the environmental problem without foregoing benefits formerly associated with use of ozone depleters.

financial assistance in the Montreal Protocol were not included from a sense of legal obligation on the part of the developed world. Rather, the irrefutable causal connection convinced the developed world that multilateral action was required, and, because all emissions had to cease, the developing world was able to use their bargaining power to demand technology transfers.

However, developing nations only signed the Montreal Protocol after receiving significant technological and financial incentives. Additionally, the developing nations ensured that they would receive the technology by conditioning their participation in emission reduction programs on effective technology transfer and financing. Since developed nations recognized the enormous problems inherent in ozone depletion and did not want to be at an economic disadvantage, they were willing to sign the conditional provision and participate in the technological transfers and financing.

B. Technology Transfers For Greenhouse Gas Emissions

Currently, there are some international agreements on global warming in force. The United Nations Framework Convention on Climate Change (UNFCC), which entered into force on March 21, 1994, is an international agreement prompted by scientific evidence showing the potential problems of greenhouse gas emissions. Although the Rio Conference, where the UNFCC was opened for signature, did not develop any protocols, the Kyoto Conference emerged with a Protocol to reduce greenhouse gas emissions. However, the Kyoto Protocol, unlike the Montreal Protocol, is not a global convention. Additionally, Dr. Watson, Chairman of the Intergovernmental Panel on Climate Change, has noted that "that the current efforts and processes will not be sufficient to facilitate the efficient transfer of environmentally sound technologies from developed to developing countries. . . ." However, Dr. Watson does state that the Kyoto Protocol is a sign that the developed world has the

170. Landers, supra note 159, at 469–70.
171. Mallery, supra note 167, at 485.
172. Wold, supra note 157, at 903; see supra note 168 and accompanying text.
175. Watson, supra note 51.
176. Id.
institutional, financial, and technical capabilities to take the first steps to reduce emissions. Since technology forcing is likely to occur only in the context of an internationally coordinated program of emissions reductions, a protocol more rigorous than the Kyoto Protocol must be established.

The Kyoto Protocol met with strong criticism and has yet to be ratified. In order to overcome those problems, the next protocol must apply the lessons learned from the Montreal Protocol's success. Fortunately, the four factors essential to the ratification of the Montreal Protocol are now present in the global warming debate.

1. The Current Scientific Evidence on Global Warming

First, the most recent scientific evidence is much more conclusive than the evidence available during the Rio or Kyoto Conferences. The strongest argument opposing emission reduction is the lack of causation between emissions and large visible environmental problems, such as the hole that developed over Antarctica, which prompted the Montreal Protocol. Indeed, a similar argument was effective in delaying an ozone-depletion treaty. The battle for the Montreal Protocol was a losing one until overwhelming evidence proved the causation between emissions of chlorofluorocarbons.

As early as 1989, scientists were stating that the greenhouse effect is one of the most well established theories in atmospheric science. At that time, scientists could not agree on the amount that the Earth's surface temperature would rise. The most recent scientific evidence, however, has made it clear that not only is the Earth's temperature rising

177. Id.
178. Michaelson, supra note 90, at 102 n.118.
179. Kyoto Protocol: Status of Ratification (last modified Feb. 5, 2000), http://www.unfccc.de/resource/kpstats.pdf. The Kyoto Protocol will be ratified 90 days after 55 Parties to the Convention have ratified it. Press Release: 84 Signatories to the Kyoto Protocol (last modified Mar. 16, 1999), http://www.unfccc.de/media/presskp.html. Only 22 of the 84 signatories have ratified as of January 13, 2000. Notably, the Montreal Protocol was initially signed amid strong criticism that the targets were "overly ambitious." Landers, supra note 159, at 466. This criticism could not stop the Montreal Protocol's ratification, indicating that criticism of the greenhouse gas targets will not derail negotiations if the other four factors have been satisfied.
181. McClymonds, supra note 3, at 615.
182. Stephen Schneider, The Greenhouse Effect: Science and Policy, 243 SCIENCE 771, 771 (1989). The National Resource Council found that there is a warming trend during the 20th Century; the Intergovernmental Panel on Climate Change's draft of its third assessment report also finds a warming trend. McCain, supra note 42.
183. See Schneider, supra note 182, at 771.
but also that many of the doomsday scenarios have already begun to manifest.\textsuperscript{184} Moreover, the Intergovernmental Panel of Climate Change (IPCC) recently completed their third report, a compilation of all scientific data concerning global warming that amounts to a report that is over one thousand pages.\textsuperscript{185} The new study, for the first time, reports “new and stronger evidence that most of the observed warming of the last fifty years is \textit{attributable to human activities}.”\textsuperscript{186} While some skeptics have questioned the accuracy of past computer models used to predict future warming,\textsuperscript{187} the new IPCC assessment is based on new and more powerful and accurate supercomputer models.\textsuperscript{188} As with the Montreal Protocol, the best multilateral actions can only be taken when the science is close to irrefutable. The recent global warming reports have reached that point.

Because of the overwhelming scientific evidence, a growing consensus is developing on the need to act swiftly and strongly.\textsuperscript{189} Even the most outspoken skeptic of global warming, Dr. Richard Lindzen of the Massachusetts Institute of Technology, “now admits both that warming is taking place and that we are at least partly to blame.”\textsuperscript{190} Additionally, two United States Senators who opposed United States participation in an emissions reducing treaty, have changed their views.\textsuperscript{191} Senators Chuck Hagel and Larry Craig stated that “there is a coalescence of science that says something is happening with the climate, that global warming is for real and it’s an important issue.”\textsuperscript{192} Similarly, “the Global

\textsuperscript{184} Supra notes 37, 48, 82, 84, 88, 182 and accompanying text. See also Danielle Knight, \textit{Environment: Report Says Global Warming Measures Can’t Wait}, INTER PRESS SERVICE, Jan. 23, 2001 (noting that new evidence from tree rings and ice cores were analyzed as well as improved computer models based on weather records).


\textsuperscript{187} Id.


\textsuperscript{190} Geoffrey Lean, \textit{Flooded Britain: If We Don’t Act Now, It’ll Be Too Late}, THE INDEPENDENT, NOV. 5, 2000, at 16.

\textsuperscript{191} \textit{Critics of Climate Change Treaty Switch Views}, MEGAWATT DAILY, NOV. 21, 2000.

\textsuperscript{192} Id. Senator Craig has also said the following:

They’ve now said the Earth is warming and it is warming at a higher rate than a cyclic warming would cause . . . I’ve looked at their research, and I have no reason to believe they’re wrong. The majority of our scientists and the majority of the world’s scientists now agree that greenhouse gases are a contributing factor, up to 40 percent.

Climate Coalition, a powerful business group supported by major oil and energy companies, which formerly questioned the evidence that human activity has contributed to global warming, has reversed its stance. It now accepts that global warming is a problem that needs to be addressed. Even the staunchest opponents to the global warming theory are conceding that the causation is now irrefutable.

2. The Need for Multilateral Action

Second, science has proven the need for multilateral action. As with the Montreal Protocol, it is clear that unilateral action will only delay the negative effects because emission reduction on the part of a few nations will be insufficient to prevent a global warming catastrophe.

While developed nations are currently the primary producers of greenhouse gas emission, developing nations are rapidly increasing their emissions. The developing world is primarily responsible for deforestation, which reduces the available carbon sinks. Additionally, even if the developed nations managed to cease or reduce their greenhouse gas emissions, the emissions by the developing nations would simply overwhelm any benefit, making unilateral action almost futile. Moreover, the developed nations do not want to place themselves at a competitive disadvantage by changing to alternative technology while other countries continue to use older, and therefore inexpensive, technology. Thus, the problem of global warming requires a multilateral solution.

3. Viable Alternatives Exist to Carbon Dioxide

Nations must be convinced that viable alternatives to coal and fossil fuels are available. For the United States, coal power is the cheapest and most common power source. The problem is that when burned, coal releases high amounts of greenhouse gases. Fortunately, several alternatives already exist that will reduce carbon dioxide emissions while still producing the requisite amount of energy.

194. Knickerbocker, supra note 27, at 7; Coleman, supra note 28, at 33.
195. *Supra* notes 16, 17 and accompanying text.
196. Langley-Hawthorne, supra note 156, at 298.
197. See generally *id.* at 277.
198. Mallery, supra note 167, at 473. For example, over 51 percent of United States electricity is generated from coal. *Id.*
199. *Id.*
200. Some industrialists have suggested that intensive use of carbon sequestration, removing carbon dioxide through tree and plant absorption, would be sufficient to compensate for global warming. *Carbon, COP6 and Global Warming*, POWER ECONOMICS, Jan. 30, 2001, at 16. Others have suggested that soil has the potential to prevent a large proportion of the annual increase in atmospheric concentration of carbon dioxide. Fred Pearce, *Ground-
To reduce emissions in power plants, several recent technological advances promise lower emission alternatives to our current coal utilization technology. A combined-cycle, natural gas facility now exists as a viable alternative to coal based facilities because it can produce the same amount of electricity while emitting half as much carbon dioxide and almost no sulfur dioxide, particulates, or nitrogen oxide. The first Siemens Westinghouse gas turbine has been undergoing prototype testing in full combined cycle since April 21, 1999. After extensive testing, the turbine is scheduled to “go commercial” in December 2001, thereby converting the plant to a combined cycle configuration and indicating that combined cycle facilities are a viable option for businesses. Notably, the IPCC recommended combined cycle-gas turbines as a means of emission reduction. Most importantly, a combined-cycle, natural gas facility not only has reduced emissions but is also relatively inexpensive.

In another scientific breakthrough, the Power System Development Facility announced successful test results of a coal gasifier, called a

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201. Mallory, supra note 167, at 473.
203. Id.
204. Jeffrey Kluger and Michael D. Lemonick, A Climate of Despair, TIME, Apr. 23, 2001, at 50. “The new hardware operates at up to 60% efficiency, nearly twice that of any other turbine. Add a device that captures escaping heat and use that to warm buildings, and the efficiency jumps to 90%.” Id.
205. Mallory, supra note 167, at 473. “Combined-cycle facilities can produce power at about three cents per kilowatt-hour, versus an average of two to five cents per kilowatt-hour for regular coal facilities.” Id.

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“transport reactor.” The gas produced from coal can be used in future turbines or fuel cells to generate cleaner electricity. Because of its simpler, more compact, and more efficient technology, the transport reactor also costs less than other systems. By using the gas produced by coals, the emissions are greatly reduced.

A third option is to use biomass as a fuel source with subsurface sequestration. Fuel gas derived from biomass can be pressurized, and its carbon can be chemically stripped, leaving hydrogen. The hydrogen can be burned or used to power a fuel cell, while the carbon can be removed to a suitable underground rock reservoir for permanent storage.

Finally, several of the “traditional” alternative methods have become viable as methods of capturing energy. For example, the German Wind Energy Institute has reported that wind turbine technology is now of sufficient size, reliability, and efficiency to use in the North Sea environment.

A major source of carbon dioxide pollution comes from burning fossil fuels in automobiles. Scientists have developed three promising new technologies to aid in reducing automobile emissions. At the Massachusetts Institute of Technology, a new device has been developed that cleans emissions by producing pure hydrogen that is then added to the engine's fuel mixture. The device also allows use of a variety of unconventional fuels, such as natural gas, diesel, and vegetable oil, in a car engine. When automobiles use unconventional plant-derived fuels, the fuel produces no net effect on the amount of carbon dioxide in the atmosphere.


207. Id.

208. Id.

209. Chadwick, supra note 200, at 134.

210. Id.

211. Id. The carbon dioxide can be captured at the point of emission, and the underground storage completely isolates the carbon dioxide from the atmosphere; Id. at 134–34. Such a system is ideally suited for large industrial point sources. Id. Additionally, one subsurface reservoir in the North Sea is estimated at being able to contain the annual output of about 925 coal-fired power stations. Id. at 135.

212. Brian Kenety, Wind Power Viable for North Sea Countries, INTERPRESS SERVICE, Nov. 6, 2000. Additionally, adverse impacts on birds, sea mammals, and other flora and fauna are unlikely if good practice is followed. Id.


Fuel enters a chamber, mixes with air, and then is zapped with electricity. That creates a plasma—an electrically-charged gas—which then causes carbon from the fuel to join with oxygen from the air. This leaves a mixture of carbon monoxide and hydrogen, both of which can be burned by the engine.

Id.

214. Id.
mosphere.\textsuperscript{215} Even more importantly, the device will not cause a major increase in costs or inconvenience to the driver.\textsuperscript{216}

A second device developed for automobiles will reduce diesel emissions.\textsuperscript{217} Westport's device uses high pressure direct injection to use natural gas in the engine.\textsuperscript{218} Limiting or eliminating diesel gas significantly reduces the amount of carbon dioxide emissions.\textsuperscript{219} Not only is this technology economically viable, but Westport is using the technology to develop natural gas fuelled electric power generators, which would reduce emissions from another major source of pollution.\textsuperscript{220}

Automobile manufacturers also are heralding the advent of hydrogen powered cars. According to Nick Scheele, the chairman of Ford Europe, "hydrogen-powered motor vehicles are expected to replace conventional fuel-powered cars within the time range of a generation."\textsuperscript{221} Others believe that the hydrogen powered cars will be available as soon as 2004 or 2005.\textsuperscript{222} Ford's hydrogen powered cars would only emit water, avoiding carbon dioxide emissions entirely.\textsuperscript{223} The hydrogen flows into fuel cells, which initiates a chemical reaction producing electricity.\textsuperscript{224} Until these fuel cell vehicles are available, hybrid cars offer a fuel-efficient and emission reducing alternative.\textsuperscript{225}

\textsuperscript{215} Id.
\textsuperscript{216} Id.
\textsuperscript{217} Westport Innovations Inc. Receives Canadian Pollution Prevention Award, CANADA NEWSWIRE, May 4, 2000. [hereinafter Westport Innovations].
\textsuperscript{218} Id. Heavy-duty trucks would ignite the natural gas with a small amount of diesel fuel, and light-duty vehicles would use no diesel gas at all. Id.
\textsuperscript{219} Id.
\textsuperscript{220} Id.
\textsuperscript{221} Car Manufacturer Predicts Advent of Pollution-Free Vehicles, XINHUA GENERAL NEWS SERVICE, Feb. 6, 2001. “We believe that fuel-cell cars have the potential in our lifet ime to end the 100-year reign of the internal combustion engines.” Id.
\textsuperscript{222} Hana Berlin, Cars with a Conscience; Cleaner, Greener Hybrids on Road to America's Future, CAPITAL TIMES, May 10, 2001, at 6E (quoting Jonathan Foley, Academic Program Director for Environmental Studies at University of Wisconsin-Madison).
\textsuperscript{223} Id. There is a split in the auto industry regarding how to extract the hydrogen. DaimlerCrysler wants to use methanol as the source for hydrogen, and General Motors and Toyota prefer to extract hydrogen from gasoline. Ted Evanoff, Cell Division Methanol or Gasoline?, THE INDIANAPOLIS STAR, Apr. 8, 2001, at E01.
\textsuperscript{224} Evanoff, supra note 223, at E01. The main problems with fuel cells right now their bulk and their expense. Amory B. Lovins and Brett D. Williams, From Fuel Cells to a Hydrogen-Based Economy: Use of Compressed Hydrogen Gas in Motor Vehicles, PUBLIC UTILITIES FORTNIGHTLY, Feb. 15, 2001, at 12. Strategies are being developed to overcome the structural difficulties, and, after mass production, “fuel cells ultimately should prove cheap, rugged, and easy to make.” Id.
\textsuperscript{225} Berlin, supra note 222, at 6E.

Hybrids combine an electric motor with a separate gasoline or diesel engine. Because they are fuel-efficient and reduce emissions, hybrids can dramatically decrease greenhouse gas emissions. For example, the Toyota Prius cuts carbon emissions by 50 percent compared to the conventional Toyota car. Hybrids also in-
Even industry officials have begun searching for mechanisms to prevent global warming. BRT, a group of CEOs from leading U.S. corporations, recently released a study listing promising technologies that could be used to reduce emissions in every sector of business. Industry officials also recognize, however, that these technologies will not be globally used unless they are also economically viable. As the president of Westport, David Demers, stated, "clean-air technologies... have to make economic sense in order for them to be adopted and have any meaningful impact on air quality." The technologies that are currently being developed to reduce emissions are viable both environmentally and economically.

4. Developing Countries' Bargaining Power

The need for multilateral action on the part of both industrialized and industrializing countries necessarily means that developing countries having significant bargaining power. This bargaining power gives developing countries the ability to demand a technology transfer and financing clause similar to that implemented in the Montreal Protocol. Developing countries already have increased their bargaining power by negotiating as a coalition, known as the Group of 77. Although developing countries have begun to recognize their power, they have yet to effectively use it.

After the Rio Conference, the developing nations began to be aware of the power they held in the global warming negotiations.

A new bargain is being forged now because the North is in a very real sense at the mercy of the South for the first time in history. If the South proceeds to destroy its forests and industrialize with the same frantic pace as did the North, the fragile ecosystems of the planet will probably not be able to sustain the consequences. Hence, the South has found a card-environmentalism-and is

crease gas mileage. The Honda Insight gets 61 miles per gallon in the city and 68 mpg on the highway. The Toyota Prius gets 45 mpg in the city and 52 mpg on the highway. Each costs about $20,000.

Id. Additionally, the Intergovernmental Panel on Climate Change recommends using hybrid gas-electric cars. Klugar and Lemonick, supra note 204, at 50.

226. Carey, supra note 89, at 103.


228. Westport Innovations, supra note 217.

229. Wold, supra note 157, at 902.
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playing it to demand less economic inequity and a fairer share of the economic wealth of the planet.230

Emission reduction plans must be implemented multilaterally, and for that reason, developing nations have tremendous power. Of course, this power can not be effectively used until the other three factors are in place, namely, irrefutable scientific evidence, recognition by the developed world of the need for multilateral action, and viable alternatives to carbon dioxide emitting technology.

Unfortunately, the results of the most recent Kyoto Protocol meeting at The Hague in November were not promising. A group known as "the Umbrella Group," composed of the United States, Canada, Japan, and Australia, refused to compromise in two demands: (1) that increasing use of carbon sinks such as trees and soil "count" as part of the mandatory emissions decrease and (2) that emissions trading is allowed between countries.231 Many participants at the Kyoto Conference, including the G-77 Chairman, blamed the Umbrella Group for the failure to reach an agreement.232 While trees and other carbon sinks should be encouraged, they cannot serve as a dependable mechanism for carbon emissions reduction.233 Since November, however, one significant factor has changed. Although an early draft of the IPCC report summary was leaked at the conference and widely discussed,234 the representatives at the conference could not fully incorporate the new information into their proposals and negotiations. Additionally, some may have doubted the accuracy of its summarization and may not have given the report much weight because it was an unofficial draft. Since the November meeting, the final version of the report has been released, and it includes irrefutable proof of the causal connection between human activity and global warming.235

At this point, all four factors are fulfilled. Because a multilateral treaty must include developing countries and all parties are aware of the

230. Panjabi, supra note 6, at 511 n.182.
232. Sabaratnam, supra note 231, at 1.
233. See supra note 200 and accompanying text.
235. See Knickerbocker, supra note 185, at AA12; see also supra Pt. III(B)(1). The report's draft summary was issued by scientists and UN officials meeting in Shanghai at the end of January. See Knickerbocker, supra note 185, at AA12 (also noting that the UN report is likely to accelerate efforts to control climate change). Notably, the report is the UN's official appraisal of the state of the science of climate change and is accepted by all governments as authoritative. McCarthy, supra note 188, at 9.
seriousness of global warming, the developing countries are in a position to demand technology transfers and funding, which will allow these countries to reduce emissions without sacrificing their economic development.

CONCLUSION

The problem of greenhouse gas emissions and global warming is, by its very nature, an international problem. Although concerted action is necessary to reduce global warming, developing countries are wary of proposals that may curtail economic growth. Simultaneously, developed nations are wary of placing themselves at an economic disadvantage.

Currently, the United States is the world’s largest emitter of greenhouse gases.236 However, China and the rest of the developing world will soon outpace the United States and the other developed nations as the largest emitter of greenhouse gases.237 The fact that developing nations will soon outpace emissions from developed nations emphasizes the need for effective multilateral action to curtail greenhouse gas emissions. Until now, economic priorities have overwhelmed environmental concerns. These economic apprehensions, however, are finally placed on a backdrop of indisputable science proving the causation between emissions and global warming. The vast majority of scientists are in agreement: global warming is not only occurring, but the effects will be enormous.238

While science has proven to the world that our past technology has seriously damaged the atmosphere, science has also developed emissions-reducing alternatives. These alternatives are feasible but unavailable to the developing world. Although negotiating the Kyoto Protocol was an important step towards reducing greenhouse gas emissions, its lack of ratification makes it a very small step.239 However, the mere possibility that the Kyoto Protocol may be ratified was sufficient to attract clean development projects to developing nations.240 Knowing that the science

236. Lobe, supra note 35.
237. Id.
238. Ironically, even though the developed nations historically made the largest contribution to emissions problem, the developing countries will suffer the most by climate change and its accompanying floods, storms, and droughts. Knight, supra note 16 (quoting Nancy Kete, the director of the climate program at the World Resources Institute).
239. Michaelson, supra note 90, at 75 n.4.
240. Poor Nations Bear Heat of Climate Conference Failure: Developing Countries had Hoped for an Accord at the Hague for Aid to Help Stem the Dangers Caused by Global Warming, FINANCIAL TIMES LONDON EDITION, Nov. 30, 2000, at 12. Unfortunately, the fail-
is irrefutable, knowing that multilateral action is necessary, and knowing that alternative technology exists, the developing world, acting in concert, has the ability to force developed nations to agree to a technology transfer and financing clause similar to the one used in the Montreal Protocol, which will allow developing countries to protect the environment and their economic growth.

The outcome of the Protocol discussions in November 2000 has endangered the viability of these proposed projects in developing countries.