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Policy Integration and Life Cycle Analysis in Ecological Sustainability

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This paper explores the importance of framing in the policy making process—how public problems and their solutions are understood, defined, and conceptualized. Framing problems and solutions is a critical element of the policy making process because it shapes everything that follows. If framing is creatively and effectively pursued, it can lead to policy interventions that solve or at least remedy the problems at which they are aimed. Conversely, if framing is too narrow or fragmented or based on inadequate understanding of the nature of the problem, policy efforts will be of limited value. Creative and effective framing is particularly important in the area of climate and energy policy because the task of ensuring a stable climate for current and future generations is such a complex and far-reaching task that must incorporate a tremendously wide range of activities. In the United States, the fragmentation of power that results from the constitutional design of separation of powers and the evolution of interest-group pluralism and the large number of groups that have a voice in policy making make effective framing all the more difficult. Given the magnitude of the task to transform the American economy in ways that are more climate-friendly and ecologically sustainable, policy making in the United States will require creative and innovative ways to frame policy options such as life cycle analysis. The paper first seeks to frame the issue of climate change in terms of the policy making challenge suggested by climate science, then turns to a discussion of how policy options can be framed and how life cycle analysis might contribute to improved energy and climate policymaking in the United States.

Framing the Policy Challenges Posed by Climate Change

The Intergovernmental Panel on Climate Change (IPCC), made up of the world's leading climate scientists, released in February 2007 a report by Working Group I on the physical science of climate change. The first report, issued in 1990, argued that there was a significant likelihood that human emissions of carbon dioxide and other heat-trapping greenhouse gas emissions (GHGs) were warming the average temperature of the earth and that climate-based disruptions are already occurring in different regions and will become even more disruptive in the future. The 2007 report concludes that scientific research leads to a "very high confidence that the globally averaged net effect of human activities since 1750 has been one of warming" and that "[w]arming of the climate system is unequivocal."[2] In contrast to the third report, issued in 2001, that concluded warming was "likely" to be due to an increase in greenhouse gas (GHG) concentrations, the 2007 report argues that warming is "very likely" to be due to anthropogenic emissions.[3] Particularly significant is its conclusion that "discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns" and other current evidence of global warming.[4]

The IPCC report also includes estimates of the warming *that would likely occur* under different emissions models and scenarios. The first report, issued in 1990, suggested that average global temperatures would rise by between 0.15 and 0.3^{o}C per decade between 1990 and 2005;

the actual increase was about 0.2°C. The 2007 report projects average temperature increase for the rest of the century from 1.1°C to 6.4°C, varying according to the different estimates of the level of emissions, with the most likely increasing falling within the 1.8-4.0°C range.[5] This is a significantly broader range of uncertainty than in earlier reports, signaling the belief among scientists that climate change could be more extreme than proposed in earlier projections. Changes resulting from GHG emissions in the 21st century will "very likely be larger than those observed during the 20th century"[6]

The IPCC's 2007 report on impacts, adaptation, and vulnerability from working group II emphasized that many natural systems around the work, such as glaciers, permafrost, arctic and Antarctic, increased runoff, warming of lakes and rivers, already appear to be affected by regional climate changes, particularly temperature increases. It is likely (a 66-90 percent probability) that these changes are a result of anthropogenic warming. Other effects of regional climate changes on agriculture and forestry, human health through heat-related deaths, flooding, and droughts, may be due to climate change, but that is difficult to know for certain because of some adaptation that is already occurring and the role of other factors. n do to adaptation and non-climate drivers. If trends continue, global impacts will affect water, ecosystems, food production, human health, and coastal areas. Regional differences are particularly important to recognize because they are so uneven, with some areas such as the Arctic facing tremendous impacts from much higher warming and associated melting and sub-Saharan Africa having to deal with even greater dryness and drought. Changes are inevitable, even if emissions are eventually dramatically cut, and adaptation will be necessary to address impacts that are unavoidable do to past emissions.[7]

While there is considerable uncertainty in climate model, many lines of inquiry converge in identifying serious risks to the planet.[8] The IPCC studies are consistent with the findings of other scientific bodies. The U.S. National Academy of Science and ten other national academies from other countries issued a statement in 2005 that summarized climate science this way: "The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action. It is vital that all nations identify cost-effective steps that they can take now, to contribute to substantial and long-term reductions in net global greenhouse gas emissions."[9] Contrarians and skeptics have argued in the past that temperature increases fall within the range of natural variation due to changes in solar activity, or that human emissions could not possibly alter massive global natural processes. Given the scientific consensus that warming is a result, at least in part, of anthropogenic sources, that is no longer a tenable position.

Other concerns continue to underlie dissent from the consensus science position: some emphasize the same uncertainties discussed above, then conclude that actions should not be taken until there is more certainty to ensure that investments are cost-effective. Some argue that warming could produce significant advantages. Bjorn Lomborg, for example, concludes that more people die from extremes of cold than of heat, so climate change will likely result in lower death rates. Since humans are so adept at adapting to changes in their climate, they will adjust to climate change through air conditioning and other investments. The average temperature in large cities, he suggests, is typically several degrees higher than for surrounding areas, as much as 3-4°C, as high as some projections made by climate scientists, but life is cities is flourishing and people have been able to successfully adapt and adjust to the increase in temperature. [10]

There is no question that there are major uncertainties about the possible future of climate change, but uncertainties can cut both ways. While some who disagree with the mainstream view argue that the threat is overstated, others believe that the seriousness of the problem is understated. NASA James Hansen, the atmospheric scientist whose testimony in 1988 before Congress warning that climate change had already begun played a key role in putting the issue on the national agenda, believes that the world has at most a decade to make sharp reductions in GHG emissions, or the planet will likely be locked into climate catastrophes later in the century such as rising sea levels and extinction of species.[11] In a December 2005 lecture, Hansen summarized the situation this way: "the Earth's climate is nearing, but has not passed, a tipping point, beyond which it will be impossible to avoid climate change with far ranging undesirable consequences." The first would be the loss of the Arctic as we know it; sea level will increase slowly but once Greenland and West Antarctic begin disintegrating and feedback loops will kick in and that could raise sea levels by 25 meters.[12] Other scientists warn of impending, irreversible impacts on agricultural activity and food production, human settlements, and economic activity if emissions are not dramatically cut.[13]

Framing the Policy Options for Climate Change

A discussion of the scientific views that diverge from the consensus statements of the IPCC, the National Academies of Science, and others is beyond the scope of this paper. However, there are a number of conclusions one might draw from the current debate over climate science. Some have decided that since there are so many uncertainties concerning the causes and consequences of climate change, the most rational response is to invest in research and wait for more information before pursuing preventative policies. That is a remarkably imprudent one, given the magnitude of the risks and the long atmospheric lifetime of GHGs; it is reckless to experiment with such high stakes. It is also an ethically suspect one, given the distribution of benefits and burdens and the likelihood that those who are responsible for GHG emissions and who have enjoyed the benefits of their use will not be the ones who bear the heaviest burdens of adaptation. The wealthy will be able to buy their way out of many of the impacts, while the poor will have few options. Even if one believes there will be beneficial consequences, the most adverse impacts are clearly likely to impact the poor around the world the hardest. People affected by rising sea levels in Florida will have some resources to adapt to the change, but the millions of poor Bangladeshis who live along coastal areas will not. The differences between the impact of Hurricane Katrina on wealthy and poor residents of New Orleans is likely to be replayed around the world as climate change proceeds: wealthy residents loaded their cars and drove to safety; poor residents were trapped in their homes or inundated the overcrowded convention center.

A second option is to accept the mainstream scientific consensus and pursue a precautionary policy to minimize the likelihood of disruptive climate change. The 1992 Framework Convention on Climate Change (FCCC), to which most of the countries of the world, including the United States, are signatories, commits those nations to "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[14] There is no agreement on what concentration level would ensure that the FCCC goal of preventing "dangerous anthropogenic interference with the climate system" be met, but leading climate scientists such as John Holdren argue that, given the evidence that global change is already doing damage, it is not likely that "any level equivalent to more than a doubling of the pre-industrial CO2 concentration could

plausibly be considered compliant with the convention. While one can debate the seriousness of the impacts of a doubling of CO2, "any basis for optimism shrinks when the postulated CO2 level moves to a tripling or quadrupling." At a quadrupling of CO2, the mean surface temperature could rise from 3-9 degrees C; increases in some areas would be even higher. Models show catastrophic changes occurring at such levels of CO2, including the shut down of the North Atlantic thermohaline circulation that drives the Gulf Stream. An atmospheric CO2 concentration of 450 parts per million (ppm) (current levels are about 425 ppm) would likely be required to satisfy the FCCC goal.[15]

In order to stabilize the CO2 concentration at 450 ppm, emissions will need to be cut by from 60-80 percent of 1990 levels by mid-century. If that goal is to be achieved, emissions would continue to rise over the next few years along with the concentration levels until an agreement is in place, and then begin to fall rapidly, bringing down the concentration to the target range. The consensus that has emerged among climate scientists is beginning to appear in policy making throughout the industrialized, developed world. Despite the differences between the United States and Europe over whether to ratify the Kyoto Protocol and the unwillingness of the U.S. national government to develop a program to reduce GHG emissions, basic climate policy goals are beginning to emerge on both sides of the Atlantic.

As of the summer of 2007, twelve U.S. states have established GHG emissions reduction goals; eight of them have committed to reduce emissions by 75-80 percent by 2050.[16] The Northeast's Regional Greenhouse Gas Initiative (RGGI) was the first regional program to create binding emission limits; the governors of seven states have committed to a cap and trade system that would impose a target for reducing carbon dioxide emissions from power plants, allocate emission allowances to each source, and allow them to find the cheapest way to reduce emissions and meet their targets by trading allowances. Their goal is to stabilize emissions at current levels from 2009-15 and then reduce them by 10 percent by 2019. In July, 2007, the governors of California, Oregon, Washington, Arizona, New Mexico, and Utah formed a Western Climate Initiative to develop a greenhouse gas registry (building on California's pioneering work in this area) and agreed to develop plans to reduce emissions by 15 percent by 2020. It should be noted that the long term goals are not yet binding on state governments (California's 2050 goal is provided for by executive order), and the states are largely concentrated in the Northeast and West Coast, areas that are traditionally more environmentally oriented than the rest of the nation. But it is striking that so many states have accepted the idea of a 75-80 percent reduction goal. The magnitude of that goal also depends on what baseline is used: a 75 percent reduction in emissions from a 1990 baseline versus a 2005-2006 baseline is large, and while most states are using the 1990 baseline, some are using the current level of emissions.

Some members of Congress have also embraced the 75-80 percent target. The Safe Climate Act of 2006, H.R. 5642, sponsored by Rep. Henry Waxman (D-CA), would require the EPA to promulgate targets for a 2% reduction in GHG emissions each year from 2010-2050, resulting in an 80 percent reduction from 1990 levels by 2050 and establish a cap and trade system for major sources.[17] The Global Warming Pollution Reduction Act of 2006, S. 3698, sponsored by Sen. James Jeffords (I-VT) set a similar goal. While not as ambitious as states, in 2005, the mayors of some 132 cities formed a bipartisan coalition and agreed to reduce their emissions by 7 percent below 1990 levels by 2012 (as provided by the Kyoto Protocol, explained below), and more than 360 cities have now embraced that target.[18] In contrast, the Bush administration has embraced a policy that encourages voluntary programs to reduce GHGs and

to maintain the steady improvement in energy efficiency of the U.S. economy, measured as energy intensity or the amount of energy required to produce a unit of economic output.[19] Total emissions in the United States have increased by more than one percent a year—about 16 percent between 1990 and 2005—while the nation's GDP grew by 51 percent.[20] However, while emissions are growing at a much slower rate than economic growth, but emissions continue to climb, evidence that these policies are not reducing emissions but only slowing their growth.

Many European climate change reduction goals take a similar path:

- The EU announced in January 2007 its goal of a 20 percent reduction in GHG emissions by 2020 and a 30 percent reduction if China and other large emitters accepted a similar goal. The target was based on the estimate that in order to have a "50/50 chance of staying with in the 2°C limit, the world will need to cut greenhouse gas emissions by as much as 50% of 1990 levels by 2050."[21]
- Germany has set a goal of a 40 percent reduction of GHG emissions from 1990 levels by 2020, provided that EU as a whole commits to a 30 percent cut.[22]
- The United Kingdom's goal is a 60 percent reduction in GHG emissions by 2050.[23]
- Norway set a goal in 2005 of cutting GHG emissions by 50-80 percent by 2050.[24]
- Sweden committed in 2005 to eliminate all fossil fuel use by 2020.[25]

The Canadian Province of British Columbia has committed to reduce greenhouse gas emissions by at least 33 per cent below current levels by 2020 (equal to reducing emissions 10 percent below 1990 levels) and to set a more ambitious goal for 2050.[26]

Opponents of climate change policies who argue that the costs of reducing GHG emissions are impossibly high clash with a number of industry executives from companies like BP, Shell, and DuPont that have set goal to reduce GHG emissions and have met or exceeded those goals and saved money in the process. British Petroleum, for example, was one of the first companies to take action on greenhouse gas emissions. In September 1998, Sir John Browne pledged that by the year 2010, BP would reduce its emissions of greenhouse gases by ten percent from 1990 levels.[27] The company met its goal in October 2001, more than eight years ahead of schedule.[28] Company officials reported that the program produced some $650 million in revenue from improved efficiency, reduced waste, and marketing of new products.[29] Similarly, Shell agreed to cut emissions by 25 percent by 10 percent from 1990 levels by 2010 and has already exceeded that goal.[30] DuPont has committed to reduce emissions by 65 percent between 1990 and 2010.[31] Climate Savers, founded by the Center for Energy & Climate Solutions and the World Wildlife Fund, works with companies to reduce GHG emissions. Johnson & Johnson has agreed to reduce GHG emissions by 7 percent below 1990 levels by 2010; IBM promised to reduce emissions by 4 percent by 2004; Polaroid, 20 percent by 2005; Nike, 13 percent by 2005; and LaFarge (the world's largest concrete manufacturer), 10 percent by 2010. [32] Michael Northrop, co-founder of the Climate Group, a coalition of companies and governments committed to reducing GHG emissions, said, "It's impossible to find a company that has acted and has not found benefits."[33]

The goal of a 60-80 percent reduction in GHG emissions is fraught with uncertainties, because of feedback mechanisms that are not well understood or difficult to predict, but if average temperature increases by more than two degrees Centigrade, scientists fear the planet would enter into uncharted waters, where the temperature would be hotter than it has been for

hundreds of thousands of years and create an environment much different than the one in which current life has evolved. Reaching the goal of a no more than 2°C increase in global temperatures and the requisite cut of emissions by 60-80 percent is also a tremendous challenge. One reason is that simply stabilizing emissions now would not lead to stabilizing atmospheric concentrations. If the emissions rate at the late-1990s rate had not increased but remained constant, concentrations would grow by about 1.5ppm/year, producing a level of about 520 ppm by 2100.[34] Given the great momentum reflected in the current energy system, global emissions will inexorably increase for at least the next several years to come even if draconian reductions were immediately made.[35]

A third option is championed by economists who believe the costs and benefits of reducing GHG emissions should be compared with those of other actions we could take to improve human well-being. Some who are often put in the skeptics of climate change camp, however, do not question the conclusions of mainstream climate science, but pose useful and important questions about the cost of alternative climate policies. Lomborg, for example, doesn't contest the research that global warming is occurring, but believes that people have adapted in the past to climate changes and will continue to do so, and the more wealth they have (that is not spent on fruitless efforts to prevent climate change), the better they will be able to adapt. He argues that the current global climate policy, the Kyoto Protocol that takes effect in 2008, will only result in very minor reductions in GHG emissions, because developing countries are not included in the regulatory program, and the large costs projected for implementing the protocol are simply not worth the very modest benefits that will be produced. A far better way to advance human well-being, he argues, is to invest in immediate problems such as reducing malnutrition, controlling preventable diseases, and expanding access sanitation and clean water in poor nations.[36]

Investing in solutions to these other problems and addressing climate change are not mutually exclusive. One could argue that we should do both. If our immediate goal is to reduce suffering and improve well being, it is clear that public health and clean water/sanitation investments in the developing world are compelling. If we can intervene in ways that reduce those problems and do so with reduced impacts on the climate, such as using clean energy sources to fuel economic activity in poor countries, we can pursue both goals in tandem. Just as compelling are policies that produce co-benefits, such as reduced GHG emissions and cuts in particulate pollution, all of which come from many of the same sources, to produce immediate improvements in public health and contribute to long-term climate stabilization goals. However, since resources are not unlimited, priorities must be set, and Lomborg argues it is much more rational to invest in the immediate public health benefits in ways that are consistent with avoiding climate change, and then take modest steps such as a small carbon tax to create an incentive to conserve and shift to cleaner fuels.

This third option is ultimately a call for a complex cost-benefit analysis that includes as benefits the value of reducing threats to water, ecosystems, food production, coastal areas, and public health and well as the more immediate public health and other positive outcomes, and as costs the expenses associated with reducing GHG emissions and funding public health and other benefits. This is a massive analytic undertaking, since most of the benefits cannot be easily quantified and monetized and there may be little agreement over exactly what specific benefits to include in the calculus. The costs are also similarly difficult to estimate because it is not clear how much control technologies and alternative energy sources will actually cost when they are

widely implemented. It is clear that, in the case of air pollution regulation, the costs of compliance have regularly been shown to be dramatically lower than regulated industries projected. Once regulatory goals are set and compliance is compelled, costs usually fall rather quickly as ingenuity and market forces creatively combine to find unexpected solutions. The goal here of finding the optimal mix of greenhouse gas emissions and temperature increases along with pursuing other pressing global problems such as providing help to poor people may be an attractive one, but it implicates a remarkably difficult and complex set of calculations.

Both the second and third options compel a careful analysis of the options for reducing GHG emissions. The attractiveness of the third option is to ensure that consideration of opportunity costs, cost effectiveness, and other analyses that compare options are central to the assessment. But there is a risk that the analysis will lose sight of the crucial role a hospitable climate plays in making all forms of life possible. If we do not get climate policy right, in terms of securing a stable and hospitable environment for human life and all other forms of life with which humans are inextricable intertwined, the consequences will be tragic even if there are many short term improvements that occurred in the interim. Because of the implications of a stable climate are so great for current and succeeding generations, there is a very compelling argument for an ethical obligation to design and implement policies that ensure the goal is achieved. Committing first to the goal of ensuring a stable and hospitable climate, based on the best science available, and then pursuing that goal through analyses of a broad set of values and opportunity costs is a prudent but also daunting way to frame climate and energy policy.

The Challenge of Reducing GHG Emissions

The goals many governments are setting goals for reductions by 2050 require fundamental transformations in energy production and use, as well as in the other activities that produce significant levels of GHGs, but there is little analysis available concerning how they would achieve such ambitious targets. Pacala and Socolow have estimated the kinds of reductions required not to cut emissions but simply to stabilize them by 2050.[37] In order to stabilize emissions at current levels by 2050, and avoid the emissions that would otherwise result from projected population growth and associated increase in energy demand, they calculate that changes need to be put in place that would reduce emissions of carbon by seven billion tons by mid century (Note that one ton of carbon = 3.7 tons of CO2). Pacala and Socolow then identify number of options or “wedges” that would each result in a billion tons of carbon not emitted. As the top figure shows, carbon emissions from fossil fuels are expected to double over the next 50 years. Their scenario would hold emissions stable until 2050 and then, as new technologies become available, dramatically cut emissions throughout the second half of the century. Achieving the "stabilization triangle" involves cutting carbon emissions by about 7 billion tons a year by 2055; each wedge represents one billion of avoided carbon emissions. The level of reductions or changes in practices required to produce one wedge of carbon savings is sobering. Improving energy efficiency through dramatic policy changes could produce several wedges, for example:

- Increase fuel efficiency of light-duty vehicles to 60 mpg or reduce the number of miles driven by 50% = 1 wedge
- Install the most efficient lighting and appliance and improved insulation currently available in all new and existing residential and commercial buildings by 2055 = 2 wedges

- Ensure all lighting occurs through compact fluorescent bulbs by 2055 = ¼ wedge

Renewable energy shifts could also produce wedges:

- 80 fold increase in wind power = 1wedge
- >2 million one-megawatt turbines, 30 million hectares (the state of Wyoming)
- 700 fold increase in PV = 1 wedge
- 2 million hectares (state of New Jersey)
- 100 fold increase in geothermal = 1 wedge (but most surface sites are already being exploited; hot dry rock geothermal development is possible if drilling costs fall)

Other energy production options require major efforts to produce a fraction of what is required:

- Expand nuclear power; an increase of two times the current output=1 wedge
- Replace 1,400 coal fired plants with gas-fired plants= 1 wedge
- Install carbon capture and storage at 800 large coal fired plants=1 wedge

These are massive changes in energy policy, but if they were made, they would only *stabilize* emissions and 60-80 percent cuts would be required beyond those reductions.

Policy scholars have long observed the fragmentation of the U.S. policy making process in general, and that has been a particular challenge in environmental policy where ecological science emphasizes the interconnectedness of nature. The most obvious and essential characteristic of environmental law in the United States is its fragmentation. Pollution control sometimes does little more than shift wastes from one environmental medium to another.[38] Air pollution, climate change, and energy problems are all inextricably intertwined but policies addressing them are diffuse and uncoordinated. It is highly unlikely that the massive changes in policy required by the threat of climate change will be addressed efficiently and effectively without a transformation to a much more integrated policy making process. How can policy integration for climate-related policies occur in a process that is characterized and even championed as fragmented in many directions?

Sustainable Development as a Framework for Energy and Climate Policy

The idea of sustainable development is a logical candidate for framing the climate change issue because it is built on the ecological idea that everything is connected to everything else and the importance of integrating environmental, ecological, and equitable concerns. It reflects the idea that comprehensive, integrated policy efforts are needed to address a host of environmental threats. The idea of sustainability has well-developed roots in U.S. environmental and natural resource policy. Sustainability has been a standard for assessing the yield of natural resources such as forests, for example, have been a goal of policies for decades as land managers have sought to ensure that renewable resources are used no faster than they are replenished and can be used indefinitely.[39] In the 1970s, scholars broadened the notion to examine the extent to which economic activity, resource use, and pollution was consistent with the planet=s carrying capacity.[40] As is well known, the idea of sustainable development gained real international prominence and attention with the publication in 1987 of the World Commission on Environment and Development=s *Our Common Future* report, which urged all nations to commit to the idea of sustainable development, defined as Adevelopment that meets the need of the present without compromising the ability of future generations to meet their own needs.@[41] The idea of sustainable development was an essential underpinning of the 1992 United Nations Conference on Environment and Development (UNCED). The term was included in nearly half

of the 27 articles that made up the Rio Declaration, a statement of broad principles to guide economic development, and was the basis for Agenda 21, a detailed plan of action aimed at implementing the idea of sustainable development.[42]

Sustainable development links the wealthy and poor countries that all share the challenge of making their economies ecologically sustainable and reflective of the needs of the poor among them and those of future generations. It promises to find a path to reconciling the stubborn conflicts between environmental protection and economic growth, equality and efficiency, and the different agendas of the developed nations and the less developed world. Sustainable development, as reflected in Agenda 21 and other documents, represent important statements concerning emerging global expectations. Part of their strength comes from the way in which they represent cooperative efforts on the part of participating countries to protect the global environment and promote environmentally sustainable economic growth.

However, the global environmental agreements in place are built on the expectation that the wealthy world will provide major new sources of funding to accomplish these goals, and that expectation has not been realized. The tension between the developing and developed nations is considerable, rooted in the history of colonialism, economic exploitation, and military intervention. Those in the South fear that their aspirations of economic growth, reduced poverty and starvation, and improved health and education are now to be sacrificed in the name of environmental preservation. They worry that global efforts fashioned by wealthy nations will prevent them from harvesting their natural resources and expanding their industrial base. They believe that their dreams of an improved life will give way to a global effort to reverse the excesses of the wealthy nations that have precipitated environmental threats. The agreements in place are not enough to secure our environmental future, and new agreements will need to be negotiated for decades into the future. If commitments already made are not kept, future agreements will be all the more difficult to produce, and the goals of the environmental agreements in place will not be realized.[43]

Unfortunately, the idea of sustainable development has found little support in the United States and has never become a widely embraced way of framing public policy.[44] There was a brief flurry activity after 1992. The President=s Council on Sustainable Development (PCSD) was created by the Clinton administration in 1993. Its purpose was to bring together representatives from environmental groups, industry, and government to advise the president "on matters involving sustainable development,@ defined as "economic growth that will benefit present and future generations without detrimentally affecting the resources or biological systems of the planet.@[45] The Council=s "vision statement@ argues that a "sustainable United States will have a growing economy that provides equitable opportunities for satisfying livelihoods and a safe, healthy, high quality of life for current and future generations.@[46] It proposed a framework to guide public and private efforts in pursuit of the idea of sustainable development that addresses environmental quality and natural resource preservation, equity, economic growth, community and civic engagement, education, and international responsibility.

In the first area of improving environmental regulation, for example, the report offers a number of criteria to guide policy making. Environmental regulations need to give more flexibility to industry so they can reduce their costs and still hold them accountable for achieving public health and environmental objectives. Companies should voluntarily accept responsibility for the design, production, use, and disposal of products and their environmental consequences

throughout products= life cycles. Regulations should use emissions trading, deposit/refund systems, taxes, and other market incentives to create incentives for compliance. Encouraging companies to take responsibility for all environmental aspects of their products promises to make more efficient use of resource, produce less waste, and save money, the commission found, but it did not propose ways to encourage that form of analysis. The PSCD had little impact during the Clinton years and was abandoned when George W. Bush moved into the White House in 2001.

The United States, and Congress in particular, has not embraced the idea of sustainable development more aggressively because policy makers are still mired in the debates started three decades ago about how to improve the existing scheme of environmental law and regulation, and the enduring American conflict over the size and scope of the Federal government. [47] The debate since then has progressed little. Congress continues to debate energy, transportation, and other environmental issues with little commitment to the idea of sustainable development, stewardship over natural resources, and U.S. responsibility for solving the environmental problems to which it is a major contributor. Energy bills passed by the House in 2001 and the Senate in 2002, for example, were largely efforts to subsidize and encourage the development of new energy sources, with only relatively little attention aimed at moving energy production and consumption to more sustainable patterns.[48] Bills passed in 2007 were only modest improvements.

The political conflict over environmental law and regulation has been so divisive and time consuming that it has precluded the nation from moving toward the next generation of environmental laws that would incorporate the idea of sustainable development.[49] Rather than make regulatory programs more effective, the Bush administration and Republicans in Congress continue the decades-old debate over how to reduce the costs of complying with them by changing the process by which agencies issue regulations, the criteria by which they assess risks and balance costs and benefits, and the role of private property rights. It is difficult to move to a more ambitious agenda of sustainable development when regulatory relief is the primary environmental policy goal. Sustainable development, like any other major policy commitment, ultimately requires the support of Congress and strong, effective legislation, and the greatest failure to engage in the idea of sustainable development has been here. Leaders of both parties in Congress have virtually ignored the idea of sustainable development and the United States= commitments made at the Rio Earth Summit. For them, sustainable development is simply a problem for other countries to worry about.[50] The hostility of the Bush administration and many congressional leaders have to international commitments, along with their opposition to environmental regulation, combine to create a major barrier to pursuing the idea of sustainable development in the United States.[51]

If sustainable development is unlikely to serve as a conceptual framework for climate change policy making in the United States, what are alternatives? A cap and trade program is widely believed to be the most cost-effective way to achieve climate policy goals. States that have embraced a climate goal plan to develop a cap and trade programs and a federal program is likely to follow. Many economists argue for a carbon tax, and such a tax could be used to help a nation achieve its cap, but such a tax fails to ensure that the cap will be achieved. Many environmentalists are skeptical of cap and trade programs, but if the target is set at the level necessary to secure the environmental goal and effectively implemented and enforced so it is not breached, then such a program can be a useful way to structure overall climate policy.

Once a cap is set and the daunting task of allocating allowances around the world to ensure achievement of the cap is achieved, the policy debate then turns to how the United States

and other nations will achieve their GHG reduction targets. Energy policy will play the central role in policy design here because most GHGs result from energy production and use. The framing of energy policy is critical. Critics of climate policy making are correct to point out that a global climate accord could require trillions of dollars be spent on energy policy during the next 50 years, but that level of spending will occur regardless of whether there is a global climate agreement or goal simply because the world's energy infrastructure will cycle through its lifetime. The United States, for example, will have a virtually new fleet of motor vehicles in the next 15 years, the length of time it takes the entire fleet to turn over, and decisions made now will determine their level of energy use.[52] Over next 25 years, the United States will build or rebuild 50 percent of the current built environment.[53] The question is not whether trillions of dollars will be spent on investments that affect how we use energy, but whether those investments will be made in ways that reduce or exacerbate the threat of disruptive climate change as well as meeting future energy demand. How can decisions about energy and other key issues be reframed in ways that will help steer them towards a stable climate?

Framing Energy Policy Through Life Cycle Analysis

Energy policy making in the United States typically invokes goals of reducing the threat of disruptive climate change by lowering GHG emissions, improving national security by decreasing reliance on imported oil from politically unstable regions, creating new technologies and industries that will result in new jobs and business opportunities, and providing a stable and reasonably priced energy supply to fuel economic activity. But these bills lack a conceptual framework that can help stimulate new strategies for producing and consuming energy. The bills tend to be massive compilations of policies preferred by individual members; the more such policies that can be included the greater the number of members who are willing to support the measure. The energy bill passed by the U.S. House of Representatives in August, 2007, for example, was cobbled together from bills considered by 11 separate committees; the final version was well over 1,000 pages, and the result is a catalog of detailed policy measures such as federal funding of research and development into new technologies, tax incentives and direct subsidies to encourage the deployment of measures that increase energy efficiency and conservation and the development of alternative fuels, and regulatory standards imposed on energy producers and products such as appliance efficiency standards or corporate average fuel economy rules for motor vehicle producers. The U.S. Senate had passed a much different bill in June. When the House and Senate pass differing bills, a conference committee of key members from both chambers is convened to hammer out a compromise. But since the 2007 energy bills are quite different, so one of the chambers must pass a version of the bill passed by the other body before a conference committee can meet. All this means that, as of mid-September 2007, it is unlikely that an energy bill will be passed by Congress this year. Meanwhile, some 300 energy and climate bills have been introduced in legislatures of 40 states.[54]

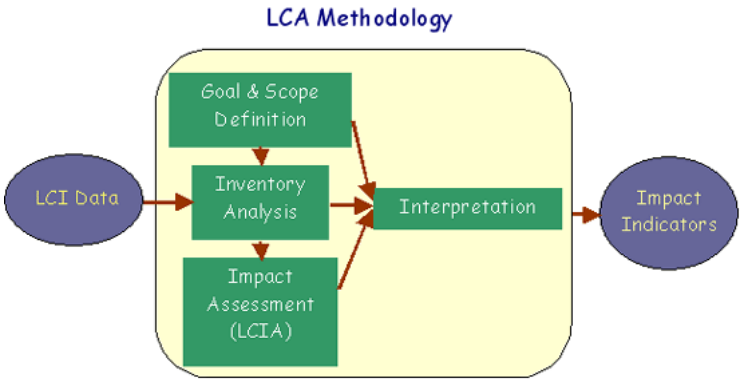
Life cycle analysis (LCA) is an attractive tool for identifying the energy and environmental consequences of major projects. LCA, also sometimes referred to as life cycle assessment and lifecycle inventory and even alternative terms such as Cradle to Grave Analysis, Eco-balancing, Ecological Footprint, or Material Flow Analysis, is rooted in the United States in energy audits and other modeling exercises in the 1970s that sough to identify the natural resources and environmental impacts associated with human activities. It was eventually employed by organizations that provided eco-labels of products and services. Producers seeking

certification are required to document energy consumption, materials used, the type and quantity of waste produced, and other relevant information, and then calculate impacts.[55]

Extended Product Responsibility (EPR) in the United States is a related effort that requires an integrated assessment of all stages of economic activity and that all those involved in the life cycle of a product--designers, suppliers, manufacturers, distributors, users, and disposers--to share responsibility for the environmental effects of the products. EPR in the United States is similar in some ways to Aextended producer responsibility@ programs in other countries that emphasize the responsibility of manufacturers for ultimate disposal of their products. Government agencies establish performance standards and ensure accountability for achieving those standards, and businesses are then free to choose how to implement them. EPR is largely a voluntary program in the United States; companies have pursued it in order to attract green consumers, make more efficient use of resources, avoid regulatory requirements, and achieve their own sustainability goals. Under EPR, companies find new ways to organize production and distribution to minimize wastes, treat wastes as assets, devise new ways of thinking about product delivery, and seek feed-back from customers in redesigning products. A number of U.S. companies, including DuPont, Ford Motor, and Georgia-Pacific, have used EPR principles to transform the way they produce their products.[56]

LCA is a systematic effort to examine the environmental impacts of the entire life cycle of a product or service, from cradle to grave. An OECD report nicely summarizes the idea: "a product's life cycle can be represented as a circular movement that ties together resource extraction, production, distribution, consumption and disposal. In other words, all the phases of organized matter and energy that are in some way related to the making and use of a product can also be linked to an impact on the environment."[57] To assist U.S. companies and governments that seek to develop LCAs for projects, the U.S. Department of Energy's National Renewable Energy Laboratory created a Life-Cycle Inventory (LCI) database that identifies and quantifies the flow of material and energy out of and into the environment for common industrial processes. A full LCA for a complex product requires the compilation of LCAs for the constituent elements of the product. The inventory can be used to assess the environmental impacts of a company, product, or technology and is made available to the public at the NREL website.[58] Figure 1 outlines the basic process: proposals for projects employ concepts from NREL's life cycle inventory to produce impact indicators that can be used to describe all of the energy and environmental consequences of proposals. Alternative projects can then be compared in terms of their lifecycle impacts and options that minimize total impacts could be selected. Impact indicators could also be used to design interventions to reduce the magnitude and extent of the impacts.

Figure 1



Source: US Life-cycle Inventory Database Project, http://www.nrel.gov/docs/fy05osti/37661.pdf

The idea of LCA is also attractive for advocates of free markets because it can help produce prices that reflect the true cost of production and distribution. The great promise that markets make of producing efficient and rational outcomes is threatened by the problem of externalities such as air and water pollution and the failure of prices to reflect all of the relevant costs. Markets often require governmental intervention to ensure that true costs are identified and incorporated into prices so that the benefits of markets can be realized, and LCA is a systematic way to identify all of the costs associated with the production and distribution of goods and services. However, the daunting problem usually remains of quantifying and monetizing all of the true costs so they can be accurately reflected in prices. LCA gets us part of the way, but it does not address the fundamental paradox that well-functioning markets require the ability to identify and monetize factors that do not have market prices but nevertheless must be included in order to produce efficient, true, full-cost prices.

Similarly, there are many significant challenges confronting would-be users of LCA. For example, LCA quantifies energy and raw materials used and waste generated at each stage of the life of a product, but may not include indirect impacts such as those generated to produce elements of the production process. How the energy is produced that a company uses in its operations may not be part of the analysis, but the nature of that energy may represent a significant environmental impact. The production of components purchased from others, for example, include consequences that are not factored into the LCA. What rates for returning recyclable containers should be used in assessments? How should the transportation costs of recycling be calculated? [59] This suggests how important it is to get all major producers of goods and services to perform LCAs.

Another challenge is deciding what constitutes the cradle and the grave for products. Recycling, for example, may result in significantly reducing the resource and environmental impacts of a product over its life cycle when compared with the same product that is not recycled. Since steel and aluminum are recyclable for many times, there may not be a practical “grave” for these materials. Paper can, with current technologies, be recycled four or five times before finally being disposed of. How much recycling should be expected in calculating the lifecycle of paper? Developing standard

measures of impacts has become an essential part of the global effort to encourage LCA.[60]

Describing the lifecycle impacts requires subjective judgments about what to include in the calculations, but even more subjective are the assessments of those impacts. Analyses of similar products may be quite different because of alternative assumptions and formulas used in making estimates. The inventory identifies the resources used and waste produced but the assessment must then evaluate the significance of the impacts such as how the impacts of different pollutants released at different volumes compare. For example:

- How can one compare heavy energy demand with heavy water use: which imposes greater environmental burden?
- How should the use of non-renewable mineral resources like oil or gas (the ingredients of plastics) be compared with the production of softwoods for paper?
- How should the combined impacts of the landfilling of wastes (air and groundwater pollution, transport impacts etc) be compared with those produced by the burning of wastes for energy production (predominantly emissions to air)?

Preserving the confidentiality of business-relevant data that could compromise competitive efforts is also a concern. Companies need to disclose production details in order provide sufficient information for assessments and for verification by others, but that runs the risk of disclosing information other companies could use to their advantage.

Broadening the Role of LCA in Policy Making. One way the use of LCA might be expanded is to require all major proposed projects to conduct the analysis before developers apply for construction and other permits. The LCA could be patterned after the Environmental Impact Statement (EIS) required under the U.S. National Environmental Policy Act (NEPA).[61] NEPA requires that all "major federal actions significantly affecting the quality of the human environment" be preceded by an environmental assessment.[62] The agency begins with identifying the alternative policies it believes would achieve its goal and selecting a preferred alternative. It then identifies the environmental impacts associated with of each of these options. If the agency believes the impacts are not significant, it can issue a Finding of No Significant Impact, and then proceed with it plans. If, however, the impacts are significant, the agency must prepare, or contract with others to prepare, a full EIS that examines and compares the environmental, social, economic, and other impacts associated with each option. The preparation of the EIS includes opportunities for public participation: the agency may hold a scoping hearing to present the idea and gather information about the range of impacts that should be assessed, hearings to discuss specific impacts, and hearings to discuss the draft EIS; the agency must circulate widely the draft EIS for public comment, and the EIS must contain a response to each of the issues raised through comments (the EIS is not required to change in response to comments, only to acknowledge them and offer a response). Once the final EIS is published, the agency may then issue a record of decision where it explains which option it selected.[63]

Environmental Impact Statements are widely used in federal agencies, in state and local government agencies that rely on federal funding or permits, and in states that have adopted their own NEPA laws. Critics of the NEPA process argue that the EIS is sometimes nothing more

than a *post hoc* rationalization for a decision already made in the agency; for that not to occur, there needs to be a strong commitment from top agency decision makers on down that the integrity of the process will be protected and that decisions will not be made until the analysis is complete. But critics go further, warning that NEPA only lays out procedural hoops agencies must jump through and only requires disclosure of information, rather than providing substantive standards for minimizing environmental impacts. NEPA's expansive substantive language, written in 1969, reflects contemporary ideas of ecological sustainability:

> It is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures…to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.[64]

Nevertheless, NEPA has been the subject of thousands of lawsuits, more than for any other environmental law, because it has been a powerful way to sensitize decision makers to environmental impacts.[65]

If the NEPA process of preparing impact assessments were combined with substantive values that decision makers were required to follow, it could be a powerful tool to vindicate and preserve those values. At minimum, a NEPA-like requirement for LCA could help sensitize decision makers to the environmental and resource consumption impacts of their decisions. Much as the disclosure of environmental impacts can result in pressure to reduce those adverse impacts, requiring the calculation of resource use and pollution production in a LCA can similarly pressure companies to reduce their impacts. The requirement could go beyond a disclosure provision to imposing more substantial obligations on companies, such as requiring them to demonstrate through LCA that the overall environmental impact of proposed projects are the lowest possible that still allow them to achieve their goals with a reasonable rate of return. Such a standard would require a great deal of additional discussion about how exactly to structure the requirement, but pilot projects and experiments could be pursued to explore ideas.

The Importance of Policy Innovation

Climate change and other global environmental threats are so complex and challenging that there is a tremendous need for creative policy experimentation to learn how best to create incentives for companies, governments, and other decision makers to make ecologically sustainable decisions. LCA promises to be a useful way for framing the issues surrounding the selection and assessment of alternatives to ensure that more of the real impacts of our practices and behaviors are reflected in market transactions. While there is modest interest in the United States in LCA, much can be learned from policy developments and implementation of LCA in Europe. Trans-atlantic lessons in the area of innovate climate and energy-related policies are critical for the United States as policy making has lagged in America. One of the central questions in environmental policy making is whether the changes that will be required in order to preserve the biosphere and use natural resources sustainably can occur through traditional legal approaches, policy-making models, and ways of thinking, or whether these changes require new paradigms, approaches, and political structures. Some argue that current legal and political conceptual frameworks are sufficient and incremental changes can produce the kinds of adjustments necessary. But incrementalism assumes that ecological change and the evolution of

ecological risks are linear and that change is sufficiently slow and that gradual policy adjustment and accommodation are sufficient. A major challenge to begin now to pursue incremental changes, learn from our experience and make mid-course adjustments, keep moving in the direction of sustainability, and build our capacity to make more effective policies, so that as political demands create the will to pursue changes, we are in position to embrace more ambitious policies that will ensure ecologically sustainable economic activity.

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[4] The report identifies the following *current evidence* concerning the effects of global warming:

- Average Arctic temperatures increased at almost twice the global average rate in the past 100 years (although a warm period was also observed from 1925 to 1945)
- Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3]% per decade, with larger decreases in summer of 7.4 [5.0 to 9.8]% per decade.
- Temperatures at the top of the permafrost layer have generally increased since the 1980s in the Arctic (by up to 3°C). The maximum area covered by seasonally frozen ground has decreased by about 7% in the Northern Hemisphere since 1900, with a decrease in spring of up to 15%.
- Long-term trends from 1900 to 2005 have been observed in precipitation amount over many large regions. Significantly increased precipitation has been observed in eastern parts of North and South America, northern Europe and northern and central Asia. Drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.
- More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. Increased drying linked with higher temperatures and decreased precipitation have contributed to changes in drought. Changes in sea surface temperatures (SST), wind patterns, and decreased snowpack and snow cover have also been linked to droughts.
- The frequency of heavy precipitation events has increased over most land areas, consistent with warming and observed increases of atmospheric water vapor.
- Widespread changes in extreme temperatures have been observed over the last 50 years. Cold days, cold nights and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.
- There is observational evidence for an increase of intense tropical cyclone activity in the North Atlantic since about 1970, correlated with increases of tropical sea surface temperatures. There are also suggestions of increased intense tropical cyclone activity in some other regions where concerns over data quality are greater.[4]

IPCC, at 8.

[5] IPCC, at 13.

[6] Expected 21st century climate changes will include the following:

- Snow cover is projected to contract. Widespread increases in thaw depth are projected over most permafrost regions.

- Sea-ice is projected to shrink in both the Arctic and Antarctic.
- It is *very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent.
- It is *likely* that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation.
- Increases in the amount of precipitation are *very likely* in high-latitudes, while decreases are *likely* in most subtropical land regions.
- It is *very likely* that the meridional overturning circulation (MOC) of the Atlantic Ocean will slow down during the 21st century…but it is *very unlikely* that the MOC will undergo a large abrupt transition during the 21st century. Longer-term changes in the MOC cannot be assessed with confidence.

IPCC, at 13, 16.

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Arizona:	2000 levels by 2020; 50 percent below 2000 levels by 2040
California:	2000 levels by 2010; 1990 levels by 2020; 80 percent below 1990 levels by 2050
Connecticut:	1990 levels by 2010; 10 percent below by 2020; 75 percent below by 2100
Illinois:	1990 levels by 2020; 60 percent below 1990 levels by 2050
Massachusetts:	1990 levels by 2010; 10 percent below by 2020; 75 percent below by 2100
Maine:	1990 levels by 2010; 10 percent below by 2020; 75 percent below by 2100
New Jersey:	1990 levels by 2020; 80 percent below 2006 levels by 2050
New Mexico:	2000 levels by 2012; 10 percent below by 2020; 75 percent below 2050
New York:	5 percent below 1990 by 2010; 10 percent below 1990 levels by 2020
Oregon:	1990 levels by 2010; 10 percent below by 2020; 75 percent by 2050
Rhode Island:	1990 levels by 2010; 10 percent below by 2020; 75 percent by 2100
Washington:	1990 levels by 2020; 70-80 percent below 1990 levels by 2050

Source: Arizona Climate Change Advisory Group, "Climate Change Action Plan," http://www.azclimatechange.us/ewebeditpro/items/O40F9347.pdf., at 7; Green Car Congress, February 14, 2007, www.greencarcongress.com/2007/02/new_jersey_gove.html; www.greencarcongress.com/2007/02/illinois_govern.html.

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Environmentally Friendly Shirts

A project in the Netherlands included an LCA for a man's shirt. The retailer who participated in this project was interested in developing an environmentally friendly range of shirts. The main questions asked were:

- Which phase in a shirt's life cycle produces the most pollution?
- Are natural or synthetic fibers environmentally preferable?

The environmental impacts of the shirts occurred during four phases:

1. Production (cotton growing, spinning and weaving, dyeing and finishing)
2. Transportation
3. Use (washing, drying, and ironing)
4. Disposal (reuse, recycling, composting, and incinerating).

The results showed that most of the environmental impact occurs during transportation to the retail outlet and during the use phase. For example, washing the shirts at 140°F (60°C) uses twice as much energy as washing them at 104°F (40°C). Synthetic or mixed textile fibers are environmentally preferable because they are easier to dry and iron, which further reduces energy consumption.

Environmental Benefits
Reduction in energy use 10%
Reduction in detergent use >20%

Economic Benefits
Consumers reduce energy costs by 10% and detergent costs by 20%.
Adapted from *Life Cycle Assessment: What It Is and How to Do It*, United Nations Environment Programme Industry and Environment, Paris, France, 1996, p. 23.

Source: US Life-cycle Inventory Database Project, http://www.nrel.gov/docs/fy05osti/37661.pdf

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