Chapter 10

Life Cycle Assessment and the U.S. Policy-Making Context

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Introduction

Environmental policy makers use life cycle assessment (LCA) to reduce scientific uncertainties about the environmental impact of technologies and products. However, the structure of the U.S. policy-making system often acts as a roadblock to the use of LCA outputs in decision making. Over the past two decades, life cycle assessment has had limited impact in determining U.S. environmental policy, either as a specific quantitative indicator or as a general outlook toward the environment. In this chapter, I discuss specific characteristics of the U.S. political system, which often make uncertainty-reducing assessments like life cycle assessment fail in a decision-making context: the incremental nature of the U.S. policy-making system; the

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place-based nature of environmental politics in the United States; and the uncertainties associated with most environmental and scientific challenges. These three essential components of environmental policy-making in the United States pose inherent challenges to the use of life cycle assessment perspectives in policy debates.

We cannot look at life cycle assessment or any other environmental decision tool in a vacuum. The effectiveness of such tools hinges on the way they interact with the political context in which environmental decisions are made. To maximize the practical relevance of tools such as LCA, we must tailor them to suit the real world of environmental politics. In this chapter, I attempt to explain the limited scope of LCA in U.S. policy-making by taking a look at the unique benefits of LCA outputs and then viewing these against the backdrop of the U.S. environmental policy-making context. In doing so, I first present a historical overview of the relationship between life cycle assessments and policy-making; next I explain the incremental nature of U.S. policy-making, the role of uncertainty in the policy-making, and the place-based nature of U.S. policy-making. The end of this chapter ties its environmental policy-making lessons together with a look at the role of life cycle assessment in the politics of climate change in the United States.

The purpose of this volume is to consider how we might increase the scope and effectiveness of life cycle assessments. In this volume, many authors have indicated some of the technical areas where LCA methodology should be refined. I argue that beyond these technical alterations, improving the "fit" of life cycle assessment outputs into the U.S. policy-making context is an important way to make LCA more effective. Without proper appreciation and consideration of the constraints posed by the relevant political context, the practitioners will continue to experience frustration in achieving the necessary political relevance of LCA—even as the methodology evolves. Methodology and studies should be designed to not only enhance the scientific and the technical validity of an LCA but also to maximize their political efficacy and the probability that LCA outputs actually inform policy debates—both goals are equally important and should be pursued simultaneously.

LCA as a Policy-Making Tool

Policy makers often have to make decisions with limited knowledge of the environmental impacts of the things they are making decisions about. Human activities have many consequences that fall under the umbrella of environmental impacts, and it is almost impossible to deduce the overall preferability of one set of options over another. Policy makers concerned with environmental protection must therefore rely upon scientific knowledge produced by tools such as life cycle assessment, impact assessment, cost-benefit analysis, and risk assessment to minimize uncertainty about products and processes and to inform decisions that allow them to implement the least environmentally harmful policies. The fundamental feature that sets life cycle assessment apart from other techniques is that LCA tracks the environmental effects of a product or a process from cradle—the resources used to create a product—to grave—the waste that results from its disposal, and including the resources used during its lifespan (Finnveden, 2000; Ross & Evans, 2002; US EPA, 2006). The output of LCA studies is an assessment of the environmental impact of a product or a service system over many different categories relative to the benefit provided by that system (Schenck, 2009). Product or service systems are different aspects of human activity, such as generating hydroelectric power, transporting goods, disposing waste, etc. We might want to know, given two options for creating the same benefit and a set of criteria to consider, which option we should select. Therefore, LCA outputs can be instrumental in evaluating different environmental tradeoffs between alternate means of providing a similar good or service. Furthermore, LCA outputs are expressed numerically, and this provides ease of interpretation for policy makers interested in comparing these alternatives (Cowell *et al.*, 2002, 881). Quantitative outputs allow policy makers to analyze the environmental damage of a product or a service simply and can allow effective and targeted decisions based on environmental criteria. This comprehensibility has proven to be one of the major benefits of LCA in political settings.

For example, once a particular substance has been targeted as harmful or hazardous to human health, LCAs can be used to adopt policies that minimize the use of that substance in a given process or product (Curran, 1997, 42). An example of this can be seen in

California, where LCA analyses have been used to minimize the leaching of heavy metals from shredder residue in landfills (California Environmental Protection Agency, 2007). Shredder residue consists of glass, plastics, carpet, and dirt, which remain after discarded automobiles and appliances are shredded and the valuable metals are collected. California generates approximately 360,000 tons of shredder residue each year, which ends up in landfills and can leach heavy metals into the surrounding environment. These heavy metals are harmful because they can contaminate surrounding groundwater tables and pollute community's drinking water, posing risks to human health. California's Department of Toxic Substance Control used life cycle assessment analyses to evaluate three alternatives to landfilling to minimize this leaching effect and identified one option—in this case, using shredder residue as fuel and mineral inputs into cement manufacturing—that emerged as a clear environmental winner (Boughton & Horvath, 2006). Specifically, recovery of shredder residue for cement manufacturing could save 1 million tons of coal from being produced each year in the United States, and the authors found that this method provided net environmental benefits across all impact categories evaluated in the study (Boughton & Horvath, 2006). LCA has been used in this way to determine the strategies that can be used to minimize a variety of environmental impacts, including greenhouse gas emissions related to global warming, stratospheric ozone depletion, acidification, photochemical smog, eutrophication, human toxicity, ecological toxicity, and resource depletion (US EPA, 2001).

The basic philosophy implicit in LCA is life cycle thinking, which considers all environmental impacts of a product or a material across its entire lifespan, instead of focusing on one specific impact or one stage of use. Today's policies are increasingly viewing environmental problems as interconnected challenges that affect air, land, or water quality across national borders. While today's environmental policies are becoming increasingly proactive, previous environmental policy-making was often corrective, or end-of-pipe, focusing on regulating selected environmental concerns (air pollution, water pollution, etc.) or individual life cycle stages (production, waste management, etc.) by applying a last minute technology fix to a technological problem. As Curran observes, "such narrow solutions run the risk of simply transferring impacts to another stage in the life cycle or resulting in little or no overall beneficial effect" (Curran, 1997, 39). Today's policy makers recognize the interconnectedness of environmental challenges, which grow increasingly complex as the world's economy integrates. LCA has the potential to aid in the institutionalization of a shift toward a more holistic and strategic approach to environmental management, because it integrates the impacts across time and space (Cowell *et al.*, 2002, 881). For example, when we decide to buy a car, we must consider not only the car's effect on local air quality but also its impact as a source of GHG emissions, the resources that were extracted to build the car, and how the car will impact the environment when it becomes a waste. LCA is designed to quantify the entirety of a car's impact and prevent environmental policies from merely shifting environmental burden from one type of impact to another or from one place to another. A report by the United States Environmental Protection Agency (US EPA) on LCA methodology uses a hypothetical situation to explain the advantage of LCA's comprehensiveness:

> An LCA allows a decision maker to study an entire product system, hence avoiding the sub-optimization that could result if only a single process was the focus of the study. For example, when selecting between two rival products, it may appear that Option 1 is better for the environment because it generates less solid waste than Option 2. However, after performing an LCA, it might be determined that the first option actually creates larger cradle-to-grave environmental impacts when measured across all the three media (air, water, land) (e.g., it may cause more chemical emissions during the manufacturing stage). Therefore, the second product (that produces solid waste) may be viewed as producing less cradle-to-grave environmental harm or impact than the first technology because of its lower chemical emissions (Curran, 2006, 3).

We see three main benefits of LCA versus other types of environmental indicators. LCA outputs (1) are able to quantify tradeoffs, (2) capture impacts irrespective of place and across different localities, and (3) measure impacts over the whole lifespan of a product or a service system. It is mainly for these three reasons that some experts feel LCA techniques will be instrumental in the 21st century phase of global environmental policy-making.

LCA has continually gained momentum as a potential policy instrument. Many governmental applications have been found for LCA studies, including product-oriented policies (eco-labeling and green purchasing); deposit-refund schemes, including waste management policies; subsidies and taxation; and finally, general process-oriented policies, like toxic substance management (Jensen *et al.*, 1997, 45). Ross and Evans establish the policy-relevance of an LCA, concluding that it "is capable of assessing the trade-off between several policy options implemented at various points in the life cycle and · · · reveal the policy mix that would lead to the most beneficial outcome for the environment" (Ross & Evans, 2002, 140).

On the basis of these perceived benefits, Cowell *et al.* find that especially in European countries, "today [LCA] is increasingly used to inform public decision making" (Cowell *et al.*, 2002, 886). They discuss three examples of LCA studies informing policy-making at the national and the continental level in Europe: the European Commission's Eco-Labeling Scheme set up in 1992, regulations of Polyvinyl chloride in packaging in the Netherlands and Sweden in the 1970s, and the waste management strategies in the UK from 2000. More recently, France has gone forward with a policy that requires all the products sold in the country to have an environmental product declaration, effective 2011 (Schenck, 2009, 2). It is expected that LCA studies will provide the informational basis for this particular eco-labeling scheme and that other EU member countries will follow suit (*ibid.*), expanding the role of LCA in European environmental policy discourse.

LCA has also been used in policy discussions and decisions in the United States, though it has less impact in the United States than it has in the European states. Several U.S. states and municipalities have successfully used LCA as a decision support tool (Schenck, 2009). Notable among these is the State of California's Office of Pollution Prevention and Technology Development, which has conducted a series of LCA studies, including the shredder residue assessment discussed above, to guide its hazardous waste management policies (California Department of Toxic Substance Control). Environmental groups such as Green Seal have moved forward in using LCA to frame their activities, and businesses commonly use similar assessments to lower the environmental and financial burden associated with their practices. But achievements of equal scale have not been made at the national level in the United States.

President Clinton's two terms in office witnessed a modest but definitive incorporation of life cycle assessment to help guide environmental policy at the national level. Under his leadership, the federal government changed its guidelines to allow for the use of LCA in guiding purchasing decisions. A report by the EPA summarizes the policy basis for the guidelines:

> In October 1993, President Clinton signed Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention," which directs Executive Agencies to evaluate the environmental attributes of the $200 billion in products and services purchased by the Federal government each year. Executive Order 13101 entitled "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition," signed September 14, 1998, further defines the Federal government's preference for "environmentally preferable" products and services (US EPA, 2000, 1).

Responding to the opportunity provided by the new federal mandates, the EPA developed the Framework for Responsible Environmental Decision-Making (FRED), which is "a practical methodology to guide environmentally preferable purchasing" (*ibid.*). Many states followed suit, mandating "life cycle analysis" considerations be used in purchasing decisions (Lowman, 1997, 4). Notably, the approach institutionalized in FRED "involves integrating price, technical performance and environmental information based on LCA into purchasing decisions" (1). Since the development of FRED, other government departments have begun using LCA in their policies. For example, the United States Forest Service uses LCA to make recommendations for design professionals to use reused as opposed to virgin wood products (Bergman, 2009). The choice of LCA to inform these recommendations was based at least partially on the growing acceptance of LCA internationally and domestically (*ibid.*).

Some argue that on the market-driven basis of this type of environmental policy, the use of LCA should be scaled up in U.S. environmental policy-making. Schenck argues, "the use of LCA as a policy instrument provides many opportunities for rational and cost-effective environmental decision-making and can provide substantial economic incentives to those organizations embracing environmental sustainability as a business strategy" (Schenck, 2009, 1). Looking at regulations under the Clean Air Act and the National Environmental Policy Act alongside other policy arenas, she concludes, "within the US, the broad use of LCA in regulations can decrease compliance costs and increase effectiveness...and its use in policy creates many ways for U.S. business to be globally competitive (5)." Such arguments demonstrate willingness for more widespread adoption of LCA studies and the principles in environmental policy debates in the United States.

However, adopting a more widespread use of LCA in U.S. environmental decision- making may not be easily achieved. Like most decision-making tools, the uptake of LCA in the political realm is affected by the structure of the American policy-making environment. In fact, some have argued that the very basis of LCA as an environmental indicator makes it incompatible with the environmental policy-making system in the United States. Bras-Klapwijk shows that the "development of the LCA methodology has been based, consciously or unconsciously, on a...normative view of sound public policy-making and analysis known as the rational theory" (1998, 335). The rational-comprehensive policy-making model claims that public policies are determined by the identification of targeted goals and an analysis of the optimal way to achieve those goals, comparing all available means. It is assumed that policy makers will be able to objectively evaluate among alternatives and pick the best one (Bras-Klapwijk, 1998). Such a model assumes a decision-making context where "The environmental planner is more of an apolitical, technical expert, striving to engineer a harmonious relationship between nature's and man's works to avoid irreversible damage and to secure the long-term viability of ecosystems" (Briassoulis, 1989). LCA was crafted with such a process in mind, and its success is therefore somewhat dependent on the presence of this type of policy-making. The nature of LCA methodology—its quantitative output, comprehensiveness across life cycle stages and cumulative impacts across geography—was tailored to guide policy makers who operate in a rational public policy setting. However, the reality is that the structure of environmental policy-making in the United States is incremental, not rational and comprehensive. Policy does not advance smoothly toward a clear optimal end state. This reality may cause occasional frustration, but the rules of environmental decision making necessitate that we consider this reality in designing political strategies for environmental issues.

In the rest of this chapter, I will discuss the nature of the U.S. policy-making environment as it relates to life cycle assessment. I will focus on the incremental nature of environmental policy-making and its deviation from the rational comprehensive model on which LCA was created. It is my contention that the U.S. environmental policy context must be taken into account when we seek to change the underlying methodologies of decision-making tools such as LCA. Otherwise, LCA runs the risk of becoming a tool that is increasingly analytically sound, yet remains unable to influence environmental policy in any meaningful way—or perhaps even makes policy outcomes worse (Bras-Klapwijk, 1998).

The Policy-Making Context in the United States: Incrementalism

The United States policy-making more often resembles a meandering series of policy steps than a linear trajectory toward a specific policy goal. It can be said that the political setting in which modern American environmental policy-making takes place is defined primarily by incrementalism (Brulle, 2010, 11; Repetto, 2006). Environmental policy progress is not made steadily, but typically happens in fits and starts. The reality that the policy advances through "piecemeal gradualism" contrasts with the idealized vision of the policy-making process that characterizes the rational model of environmental politics (Lindblom, 1979). In this model, the outcome of environmental policy should be the "selection of the best solution that meets objective scientific criteria" (Briassoulis, 1989, 384). Life cycle assessment fits nicely into the rational decision model because outputs identify a clear environmental winner between a set of products or services (Bras-Klapwijk, 1998). The expectation is that the results from an LCA will be taken as a factual statement of environmental preferability and then used to design an optimal environmental policy. However, in American politics, policy decisions require crosscutting consensus across ideological lines, and this demand for consensus tends to guide policy makers cautiously away from environmental damages, rather than toward an agreed-upon environmental goal, complicating the seemingly simple process of choosing the least environmentally harmful product option (Braybrooke & Lindbolm, 1963, 71). Given the disjointed and incremental advance of U.S. environmental policy, it is unsurprising that LCA as presently practiced has not achieved serious political relevance in the United States.

The structure of the U.S. government in many ways conditions the incremental policy-making approach. Lindblom observes a "structure of veto powers," both explicit and implicit, which guide society toward incremental political moves (1979, 520). The process of reconciliation between the House and the Senate guides policies toward consensus rather than fundamental and structural policy reforms (Selin & VanDeveer, 2011, 15). Separation of powers—the fact that multiple branches of government are open to challenge or obstruct environmental policies—can also contribute incrementalism (Repetto, 2006, 3). Plus, this type of policy-making suits the needs of politicians, as it allows them to minimize risk by taking small steps in reaction to an environmental issue, instead of taking deliberate, large leaps that might marry an individual to a particular issue. Politicians' own time horizons are based on the electoral cycle and are much shorter than the time horizons over which long-term environmental challenges play out, which often causes policies to focus on short-term, instead of long-term benefits. As Hammond *et al.* put it, "Policy makers have high career stakes in the success or failure of policies for which they are responsible" (Hammond *et al.*, 1983, 20), and this creates an inherent risk-aversion that is embedded into the political process.

However, incrementalism does not in itself preclude the passing of effective environmental policies. According to Lindblom, "incrementalism in politics is not, in principle, slow moving... A fast-moving sequence of small changes can more speedily accomplish a drastic alteration of the status quo than can an only infrequent major policy change" (1979, 520). His line of reasoning stems from the very basis of incremental politics: because it by definition does not stray from the existing consensus, incrementalism as a policy feature minimizes the polarization and values-based hostility that more drastic reforms may stir up. A classic example of the latter approach is the current state of U.S. climate change politics, which inflames much partisan rhetoric while accomplishing very little on the ground. Therefore, though smaller in scope, incremental policy outcomes can come about at a relatively consistent pace, which has ramifications for our current slate of pressing environmental issues. Applying this notion to climate change, Levin *et al.* (2007) devise a strategy that they term "progressive incrementalism." (2007, 11).

They seek to upset the current stalemate on climate change policy through the implementation of carefully selected, yet incremental policies that would counter current practices and "lock-in" more sustainable ones. Their strategy hinges on the notion of path-dependency in policy-making: "The goal of our approach is to identify those policies that once enacted are both difficult to reverse, and in the most promising cases, become more entrenched over time" (13). Therefore, it is false to assume that incrementalism closes off the opportunity to address environmental issues in a meaningful way. The challenge for the LCA community is to accept the reality of incremental policy-making while crafting new environmental information that fits into the incremental pattern by insulating itself from the perils of partisan politics.

Non-Incremental Leaps in Policy

As we saw in the flurry of environmental legislation passed during a short period of the 1970s, great environmental policy leaps and policy innovation are possible. Braybrooke and Lindblom refer to "grand opportunities," which can often jolt the policy-making process out of the pattern of incrementalism. For example, Charles O. Jones, writing in 1974, observed that the 1970 Clean Air Act was an example of a non-incremental leap over previous air quality legislation (438–464). In his view, the increase in public concern and a change in the public's attitudes regarding air quality created a "grand opportunity" for change and for successful problem solving. What had been a poorly understood and tentatively addressed concern was transformed by media attention and popular awareness into a solvable policy problem. While we saw this with the 1970 clean air legislation, we did not see it in 2010 when the U.S. Senate considered enacting climate legislation.

Certain environmental issues are able to gain enough traction to leapfrog the incrementalist status quo. Repetto writes about the existence of "positive feedback loops" hidden within the structure of environmental policy-making that can interact to shift the system away from incrementalism, if only temporarily (2006, 11). The presence of these feedback loops gives the policy-making system the capacity to allow some environmental policy issues to advance non-incrementally. Holt and Barkmeyer stress the importance of media in this process, particularly its "vital dual role in agenda setting and transmitting information" (2010). If people perceive that a problem seriously threatens their well-being or the well-being of their families, then an environmental issue can become a major factor in national politics. But it is not enough for scientists or other experts to "know" that the problem looms—the public must witness and feel its daily effects, which often requires media attention. Others point to positive feedback loops within the political process itself. One important theme is the role of "political entrepreneurship" in bridging the gap between the public and the policy-making apparatus and consolidating these deviations from the incremental standard (Lyons, 1999, 290; Repetto, 2006, 11). Referring back to the Clean Air Act and other landmark environmental laws of the 1970s, Lyons argues that, even as the visibility of issues was rising, the role of Senator Edmund Muskie's policy entrepreneurship provided critical leadership in transferring the momentum into legislation (1999, 290). Political entrepreneurship consists of the active mobilization of public sentiment on the part of enterprising political figures, despite the associated political risks, and helps increase the political salience of environmental issues that concern the public. Leadership at these critical junctures can become institutionalized given the prominence of "bandwagon effects" in American politics (Repetto, 2006, 11). Thus, the political process retains the capacity to dynamically address certain environmental issues.

Brulle identifies four main drivers of environmental politics, creating a framework with which to consider this dynamic issue: the political opportunity structure, the structure of the environmental movement, cultural dynamics in relation to environmental issues, and mobilization in response to environmental conditions (2010, 9). While incrementalism may generally inhibit major changes in legislation, changes along any of the four dimensions, if sufficiently powerful, can restructure the nature of environmental politics in relation to that issue. Brulle provides a particularly potent example, given the 2011 earthquake and tsunami in Japan: "early nuclear accidents were virtually unnoted by the mass media and policy makers in the 1950s (e.g., the Fermi near disaster), creating no public response, but Three Mile Island and Chernobyl stirred considerable protest and mobilization in the 1980s. This was due to a reframing of nuclear incidents as potentially catastrophic in nature" (2010, 12). Despite the presence of incrementalism as a structural attribute of the environmental policy-making context, the relationship between America's politics and the environment is far from static and often changes on the basis of public interpretation of environmental events.

The notion of "punctuated equilibrium" has emerged as an influential theoretical model that integrates the incremental and non-incremental features of environmental policy-making in the United States into one formula. Borrowing from evolutionary biology, Baumgartner and Jones (1991) adapted the concept and applied it to explain the pattern of general stability coupled with rapid change evident in many policy areas. Despite the infrequency of non-incremental leaps, the authors show, "Often, the grand lines of policy may be settled for decades during such critical periods of mobilization" (1991, 1044). In this model, the discontinuous breaks from incrementalism discussed above serve as "focusing events" or as Birkland (cited in Brulle, 2010) explains, external stresses that "change the salience of issues and sometimes replace indicator-based analyses with much more emotionally charged examples of policy failure and the need for reform" (Brulle, 2010, 12). Such events can increase the political visibility of an issue and funnel the attention of the public and policymakers toward environmental reform, disrupting the incrementalist equilibrium. Thus, the punctuated equilibrium model focuses on the "interaction of beliefs and values concerning a particular policy...with the existing set of political institutions" (Baumgartner & Jones, 1991, 1044). This dynamic model shows that both incremental progress and non-incremental leaps are fundamental components of American environmental politics. Understanding the overall environmental policy-making process, including both incremental and non-incremental events, will help life cycle–assessment practitioners create LCA outputs that may be more useful in translating environmental data into policy. An interesting feature to keep in mind is the one that makes intuitive sense but is often ignored by those caught in the environmental policy debate: people react much more strongly to events that are emotional and personal than ones that are numerical and empirical. While this flies in the face of rational public policy as well as those trained in the scientific method, it does allow for creative use of environmental information, especially if we consider the scale at which environmental issues tend to be felt the strongest.

Place-Based Environment Politics: The Importance of Scale

While many of the most challenging environmental problems are global or national in scale, the U.S. policy-making system is typically not conducive to widespread problems. This is because the environmental policy-making system in the United States is place-based in nature. The United States' political institutions respond best when an issue is extremely visible on a local level. Take, for example, the overwhelming media and policy responses to the 2010 oil spill in the Gulf of Mexico. The magnitude of the response to the oil spill grew out of the fact that its impact had a direct effect on the lives and livelihoods of local citizens. Because of this response, plans to expand offshore drilling as part of the effort to boost domestic energy production were temporarily put on hold. On the other end of the spectrum of environmental impacts, we have climate change or marine debris, two impacts that affect the entire world's population but are less obvious on a local level and therefore don't make it onto the agenda. While international topics such as these are discussed at length and with increasing frequency in the online media, when it comes to real action at the policy level, local issues often take precedence. Thus, we witness serious resistance to the adoption of climate change legislation in the United States, despite the general public consensus in favor of environmental protection. It is possible that recognition of climate change as a cause of serious local disasters, such as Hurricane Katrina or the increasing number of tornados in the South and Midwest, could generate momentum behind U.S. national climate change legislation. But this attribution is fraught with scientific uncertainty and the politics that stem from it, a topic I will discuss at length in the next section.

It is difficult to overemphasize the power of the place-based nature of American environmental politics. Fear of environmental damage has resulted in a "not in my backyard" (NIMBY) syndrome that "often produces greater total environmental impacts in order to avoid lesser effects on a more powerful or better organized local constituency." Take, for example, the issue of nuclear waste. After the federal government has spent billions of dollars to develop and complete a nuclear waste repository in Yucca Mountain, Nevada, the Nevada delegation to the U.S. Congress, vetoed its operation. As I wrote for *The Huffington Post*:

> The "Not-in-my Backyard" (NIMBY) syndrome is a central element of land use politics in communities throughout the United States. While it is true that the definition of a noxious facility varies from place to place, no one doubts the ability of an American locality to veto a land use that they do not like. In New York City we have an extreme version of NIMBY where we even have trouble siting big box retailers. Most places are happy to allow Wal-Mart, but even before last week, few communities were interested in hosting a nuclear power plant The strength of anti-nuclear power politics should not be underestimated. In New York, people on Long Island are still paying off $3.3 billion in debt for a nuclear power plant called Shoreham that, like the Yucca Mountain repository, was completed but never opened (Cohen, 2011).

There are several explanations for the place-based bias in environmental policy. Lyons expects more widespread issues like climate change to remain in a state of political stalemate, while localized environmental issues like wastewater treatment more readily achieve political agenda status and gain traction in terms of policy outcomes. According to him, this is because of the structure of political benefits that politicians gain by pursuing certain types of environmental policies. Lyons explains, "the U.S. political system offers to politicians abundant incentive to provide tangible and specific policy benefits, yet relatively little incentive to provide benefits that are diffuse or intangible." (1999, 275). By the very nature of the functioning of the U.S. government, issues that are tangible and local are privileged over widespread ones.

Providing a different perspective, Selin and VanDeveer look at this result more structurally, and with a global perspective, highlighting the way multilevel environmental governance, such as that in the United States, which includes layers of federal, state, and municipal governments, gives political space for local actors to take the lead on environmental issues. Multilevel governance refers to the interaction of "multiple public and private sector actors operating across horizontal and vertical levels of social organization and jurisdictional authority" (2011, 6). Specific to the multilevel nature of climate change governance, the authors identify federal, state, and municipal policymakers, private sector leaders, and civil society representatives as the key players. Within the system of multilevel governance, a country's domestic politics can greatly influence how outcomes are determined (Andonova & Mitchell, 2010, 260). In the US, it can be argued that "environmental federalism," or the division of environmental policy-making roles between municipalities, states, and the federal government, is a primary characteristic of multilevel governance (Selin & VanDeveer, 2011, 12). Such an apportionment of roles has arisen primarily due to policy inaction at the national level (Selin & VanDeveer, 2011, 12) and can be seen as part of an active process of "rescaling" between various tiers of the multilevel governance structure (Andonova & Mitchell, 2010). Rescaling can be defined as "a shift in the locus, agency, and scope of global environmental politics and governance across scales," and often demonstrates that there exists a level of competition between various actors at different levels of society for increased power and control (Andonova & Mitchell, 2010, 257). As Selin and VanDeveer write, in American environmental politics, rescaling is linked primarily to competition between the various levels of government: "Since its inception, the United States has been home to contentious debates and relations between the federal government and state governments competing for legal authority and resources" (2011, 12). This theoretical approach shows that given the scaling down of environmental governance in the United States, it is only natural that local issues would be responded to more quickly than national or global ones.

The relatively modest political relevance of LCA becomes easier to explain when considering that the place-based emphasis of U.S. policy-making forms an ingrained and integral aspect of environmental policy-making. As I described earlier, LCA as a scientific input was designed to provide a holistic and comprehensive indicator that could be used in policy debates. Particularly, LCA is meant to capture environmental effects that span geographic and political boundaries. As we have seen, however, the political system is likely to produce policy solutions to local environmental problems, but structural constraints preclude the same type of consensus around global and widespread problems. Given this political context, even if practitioners perfect the ability of LCA to capture trans-geographic environmental impacts, it is not expected that LCA will become much more effective at influencing the policy debate. Instead, it might be more effective for LCA practitioners to tailor their studies so as to enable them to specify environmental damages at specific geographic scales. This disaggregation would

allow the quantified environmental damage to enter a place-based dialogue on environmental policy, possibly moving an issue onto the non-incremental, transformative track.

The Role of Uncertainty in U.S. Environmental Policy-Making

The scale of environment problems and the corresponding local, state-wide, or regional politics only partially explain the difficulties LCA practitioners have encountered in using their outputs to influence policy outcomes. The incremental and localized nature of environmental policy-making in the United States comprises one set of constraints on the use of scientific inputs in policy-making discussions. We must also consider the nature of scientific information as another important obstacle that hinders the easy uptake of indicators such as life cycle assessments. By their very nature, environmental processes are complex and intertwined. In the real world, these complexities must be simplified in order to clarify the ways human activities influence natural systems. A certain degree of uncertainty is a necessary element of any quantitative environmental indicator. Science has evolved hand-in-hand with the presence of these uncertainties, which explains why, for instance, climate models publish their results in terms of probabilities and likelihoods—a given climate prediction is deemed to be *very likely*, or *somewhat likely*, but never certain. While scientific understanding accommodates uncertainties, politics and policy-making are less ideal venues to incorporate uncertainties into their processes. Summarizing the problems this poses for politics, Hammond *et al.* write:

> Scientific statements, particularly projections of the likely future impacts of alternative policy options, are ordinarily probabilistic, complete (one hopes) with clearly stated confidence limits. Policy makers' requests for policy-relevant scientific information can seldom, if ever, receive precise, unequivocal answers. Thus, scientific information does not mesh well with policy makers' needs to make singular, discrete choices. Policy makers frequently find themselves in situations analogous to that faced by all of us at times when we must decide whether or not to carry an umbrella on a day when the weather bureau has forecasted a 20% chance for rain. (1983, 289)

Uncertainty is an intrinsic ingredient in our understanding of any scientific problem. The problem of uncertainty is more pronounced for environmental issues due to the layers of complexities present within ecological systems themselves as well as in how human and ecological systems interact. For these types of deeply interconnected systems, typical tools like the scientific method are impossible to employ because they rely on controlled variables, and there are hundreds of uncontrollable and unobservable variables present in any environmental system. Since we cannot understand what an undisturbed system looks like, quantitative data regarding changes in disturbed systems typically is inaccurate and fails to capture possible variables (Leinfellner, 1990). Furthermore, the complexity of environmental problems means simplification is a necessary component of any attempt to comprehend environmental processes—we move from the solidity of controlled experiments to the ambiguity of scientific and mathematical models. Because environmental problems are not readily reducible, choices must be made in simplifying the systems, even when we use mathematical models, and these choices can easily influence the subsequent result. As Arrow *et al.* explain, "We are relatively ignorant concerning relationships in ecosystems and are likely to underestimate the list of services they provide" (2000, 1402). While some environmental problems are scientifically simple, many environmental processes are composed of hundreds of reactions and relationships. Overlooking even one key relationship could dramatically alter the veracity of scientific outputs. Any quantitative measurement meant to convey even a portion of the total environmental impact of a man-made good or service—be it a soda can, a particular emission from a factory, or an entire transportation network—must first navigate a series of potentially distorting simplifications and assumptions.

Environmental science—and more specifically, the indicators used to demonstrate its findings—is in this way precluded from making statements with absolute certainty. Scientific and quantitative tools and techniques are constantly evolving and improving but will never deliver results completely devoid of ambiguity. It is typical to find that when harm cannot be proven, a lack of certainty often inhibits environmental protection policy. According to former United States EPA Administrator William D. Ruckelshaus, "...EPA's laws often assume, indeed demand, a certainty of protection greater than science can provide with the current state of knowledge" (1983, 1026). This highlights the importance of uncertainties attached to the proposed policies themselves. Because environmental systems are so complex, we cannot be 100% certain that a given policy will produce the intended effect without any serious side effects. This lack of certainty gives ammunition to those who are ideologically or politically opposed to environmental regulation. As our understanding of the natural world improves and as our mathematical and computational capacities increase our ability to model numerous interconnected processes and feedback loops, the challenges of uncertainty can be lessened. Improvements along these fronts would in turn influence how information is used to address environmental issues (Layzer, 2002, 230). A brief look at climate change policy in the United States under President George W. Bush makes the point. During the early years of his administration, his top advisers perceived a lack of scientific certainty about the scientific basis of global warming. As scientific consensus emerged and uncertainty was reduced, the government had more incentive to address global warming (Cohen, 2006, 30). Thus, refining the methodological aspects of LCA to make the findings more scientifically robust and less uncertain could facilitate the instrumental use of LCA in the U.S. environmental policy-making debates.

But as long as uncertainty remains, the scientific problem of environmental issues will always be at least partially subjective. Subjectivity goes hand-in-hand with simplification in the production of environmental information. Importantly, this subjectivity exists even if individual scientists adhere stridently by scientific and ethical principles. The development of life cycle assessment, both methodologically and as a political input, confirms the way subjectivity and value systems can alter the results from supposedly unbiased environmental indicators.

Subjectivity is built into the very premise of life cycle assessment. Recall the four phases of the standard LCA study: goal and scope definition, life cycle inventory analysis, life cycle impact assessment, and interpretation. Finnveden (2009) points to three sources of uncertainty that reside within these phases:

- *data*, e.g., electricity use of a heating boiler, CO_2 emissions from a coal-fired power plant, and GWP of dinitrogenoxide;
- *choices*, e.g., system boundaries, allocation principles, and time horizon in Impact Assessment;

- *relations*, e.g., the linear dependence of traveled distance on fuel input, the linear dependence of acidification on SO_2 emissions, and the discounting formula used for long-term impacts (2009, 14).

Uncertainty within these three sources can create difficulties in the transmission of environmental information into the policy-making world. For example, Cowell *et al.* make the case that "LCA results can be complicated and may require specialist knowledge for their interpretation. It can be difficult, therefore, for nonexperts to debate the validity and relevance of LCA studies in a decision-making situation" (2002, 888). In this way, uncertainty and complexity impair the ability of politicians to understand scientific outputs, given the technicality of the measurement.

In addition, there exist certain unique types of uncertainty in LCA, which necessitate subjective decisions on the part of practitioners, such as the decision whether to include water use in an inventory analysis (Finnveden, 2000, 231). For issues such as these, the importance of choices in LCA analyses increases the prominence of subjectivity on the part of practitioners. Finnveden (2000) surveyed the inventory analysis phase of various LCA studies and found that they typically "do not cover all relevant environmental aspects." As a consequence, "No conclusions can be drawn concerning the overall preference from an environmental impact perspective of one choice over another, simply because all environmental aspects have not been included" (Finnveden, 2000, 231). In this way, the selection of environmental impacts to measure constitutes a type of subjectivity in LCA analyses, limiting their capacity to provide objective policy advice.

The use of different value systems in environmental policy-making is inherently problematic. And one of the more challenging aspects of LCA is its reliance on value interpretation, which complicates the utilization of LCA studies in policy debates. Cowell *et al.*, noting the increasing awareness of value judgments within LCA methodology, highlight three areas of LCA applications that necessitate value judgments on the part of practitioners. Most basically, philosophical questions emerge. While "LCA is based on the premise that tradeoffs can be made between different environmental impacts," some argue that such tradeoffs are in principle not applicable for certain irreversible types of environmental damage (Cowell *et al.*, 2002, 887). Looking at the interpretation phase of LCA, the authors find, in line with Finnveden (2000), that this process requires the adoption of value judgment about the relative desirability of different types of environmental impacts (Cowell *et al.*, 2002, 888). Lastly, looking at the nature of LCA results, they observe, "LCA is not concerned with inherently qualitative, subjective aspects" that some may consider valuable aspects of the environment (Cowell *et al.*, 2002, 888). For example, returning to the LCA impact categories created and formalized by the EPA: global warming, stratospheric ozone depletion, acidification, photochemical smog, eutrophication, human toxicity, ecological toxicity, and resource depletion, the exclusion of other potential categories, such as animal welfare, was an inherent choice that is in part a value judgment.

The subjective elements inherent in life cycle assessment could comprise a venue for contestation of LCA-based environmental information in the political realm. In fact, Bras-Klapwijk (1998) shows how the inherent subjectivity of LCA results, when coupled with an expectation of quantitative objectivity, can easily lead to polarization in political debates that can actually result in worse policy outcomes. Even when uncertainties are explicitly presented, experience of LCAs in the political realm:

> ...shows that political actors suppressed or denied qualifications when the results were in line with their view. On the other hand, actors tended to emphasize these uncertainties when they did not agree with the result. Qualifications in LCAs often led to polarization about the quality of the study (Bras-Klapwijk, 1998, 340–341).

Arguments can always be leveled against the quantitative output of an LCA because of the inherent uncertainty of the process. While "the result from an LCA is a single observation statement," subject to different outcomes under different parameters, "a statement that one product is environmentally preferable to another one is a universal statement...Anybody who wants to challenge the results from an LCA can always ask for a new situation with slightly different properties that were not included in the original calculations" (Finnveden 2000, 234).

In this way, the fact that by trying to reduce incredibly complex systems into comprehensible pieces inevitably creates a level of uncertainty means that by their nature, life cycle assessments will necessarily be limited and constrained. Given these potential pitfalls and the possibility of political manipulation, it is necessary to consider various ways the U.S. policy-making system copes with uncertainty in crafting environmental policies, so as to move LCA outputs to better fit into the framework of environmental policy-making we observe in the world.

Case Study: Using U.S. Climate Change Politics to Explain the Limits of LCA

The case of climate change politics in the United States provides insight into the functioning of the overall system of environmental politics in the United States as I have laid out above, and it also highlights the ways this political structure inhibits the use of life cycle assessment in the surrounding policy debate. Ultimately, the dynamic of climate change politics disempowers LCA as currently conceived, by minimizing the effectiveness of science-based, rational indicators in policy-making. This is because the widespread uptake of environmental indicators hinges on values and the prevalent discourse with respect to the environment, which at present are highly polarized. Climate change deniers and opponents with political agendas have framed climate policy as zero-sum: claiming that effective climate policy can only be pursued at the expense of domestic economic prosperity (Cohen, 2006, 109). As a result, we find the debate remains stuck in a contentious stalemate, even as polls published in May 2011 by Yale and George Mason Universities found that 64% of Americans now believe that the planet is warming—an increase from similar polls conducted last year (Leiserowitz *et al.*, 2011, 2). But politicization has clearly affected the issue, as more Americans believe that disagreement rather than consensus among scientists characterizes the science that provides evidence of climate change (*ibid.*, 3). This kind of public sentiment increasingly mirrors the climate views of leading politicians, who project this perceived disagreement into the debate around climate change politics. Such views are perplexing, considering that scientific consensus is only growing, as evidenced by the publication in the journal *Science* of a letter signed by 255 of the world's most distinguished scientists defending the integrity of climate science (Gleick *et al.*, 2010). This situation of politicization and polarization explains the lack of transformative politics on this issue—confirming Brulle's contention that in the presence of severe polarization between the pro- and anti-change communities, potential focusing events such as new or improved scientific information will still fail to dislodge environmental politics from the incremental equilibrium (2010, 12).

My main argument is that climate change predominates not as a *scientific* issue, but as a *political* issue. The scientific community has commendably enhanced the quality of its work in projecting climate impacts of human behaviors. But this development has mostly occurred in isolation from the politics of climate change, which have only grown more divisive and should be considered separately from the science side of the issue. It is the political element of the issue that currently confounds scientists and environmental advocates alike. When thinking about environmental problems from a political perspective, it becomes clear that the political element explains why the numerous LCA studies on climate impacts of various aspects of our economy have not influenced the debate in any meaningful way.

It is not hard to imagine what transformative politics on climate change would look like. All countries, especially the most developed ones, would cut their greenhouse gas emissions substantially. This requires some combination of taxes or disincentives on the use of fossil fuels, subsidies to encourage the expansion of renewable energy industries, and lifestyle changes. Such changes might require a departure from the status quo, that is, from incrementalism. Many potential events could have shifted the United States out of its deadlock on climate policy, including international mobilization around the Kyoto Protocol or the 2009 Copenhagen conference, disasters like Hurricane Katrina or the recent tornadoes in the American Midwest and South, or new information and science as disseminated by the Intergovernmental Panel on Climate Change. But they haven't. Instead, we see the traditional incremental progress on this issue, which defines much of environmental politics; and as is common with incremental politics, the result is a meandering type of trajectory, defined by contentious politics between competing interest groups.

Many of the factors I described in the section on incrementalism have combined to give climate politics the disjointed "fits and starts" trajectory common to many environmental problems. These include electoral cycles and party politics, interest group lobbying, separation of powers, ideology, and heightened polarization. Consider the contours of U.S. climate change politics over the last 15 years:

- In 1997, the Kyoto Protocol was enacted at the third meeting on the Framework Convention on Climate Change. President Clinton agreed that the United States would participate in the agreement, which bound countries to emissions reduction targets averaging 5.2 percent below 1990 levels (United Nations Framework Convention on Climate Change, 2002).
- However, in anticipating of the President's accession, the Senate passed the Byrd–Hagel Amendment by a vote of 95 to 0 requesting that the United States not enter into any treaty requiring reductions that might damage the economy or hold developing nations to different commitment standard than developed nations. The Kyoto Protocol never reached the Senate.
- As of 2000, despite this inaction, the EPA accepted the fact of anthropogenic climate change as part of its official policy (US EPA, 2000).
- In 2001, President Bush formally pulled the United States out of the Kyoto Protocol.
- By 2002, he adopted a climate policy related to reducing the "greenhouse gas intensity," or the ratio of greenhouse gas emissions to economic output, of the U.S. economy. In this way, policy on climate change was integrated into economic policy and was deemed secondary to economic growth, reflecting the power of pro-business lobbying in his administration. No specific reduction targets were set. But this policy indicated the relevance of climate change to national policy debates (Cohen, 2006, 105).
- In 2003, John McCain and Joseph Lieberman introduced the McCain–Lieberman Stewardship Act, which required domestic, mandatory, and economy-wide emission reductions, but the bill was defeated by a 55 to 43 vote later that year (Pizer *et al.*, 2003, 1). Again, the lobbying of energy industry and inflamed rhetoric on both sides characterized the politics of this bill (Cohen, 2006, 114).
- After a period of Congressional inaction, the election of President Obama in 2008 seemed to signal a change in climate politics. In 2009, the House of Representatives passed the American Clean Energy and Security Act, which promoted a clean energy economy and a cap-and-trade system. A year later, the American Power Act was proposed in the Senate but failed when Democrats removed all meaningful carbon emissions legislation in order to appease Republicans and pass the bill (Hulse & Herszenhorn, 2010, 1). The passage of sweeping climate change legislation remains one of the main unfulfilled promises from Preisdent Obama's campaign.

- However, advances have been made in terms of climate change policy outside the legislative branch of government. In 2007, the U.S. Supreme Court voted to require the EPA to regulate greenhouse gas emissions as air pollutants under the Clean Air Act. The EPA is now set to regulate greenhouse gases from factories and power plants in a policy that has been under development over the past several years. Such measures are vehemently opposed by Republicans in the House and Senate, who have convened hearings intended to call into question the foundations of climate science (Revkin, 2011).
- In 2009, President Obama used his regulatory authority to "significantly increase" fuel efficiency standards for automobiles through 2016, with assent from the automotive industry. He is preparing to ramp up these standards through 2025 (Harwood, 2011).
- In his 2011 State of the Union address, President Obama set down his climate policy outside the framework of legislative politics. Though this policy falls short of a climate bill that supporters have been advocating, he did set many ambitious climate-related goals during the speech, including the manufacture and sale of 1 million electric cars in the United States by 2015 and the target of producing 80% of the nation's energy from clean energy sources by 2035. This shift in focus represents an effort to wed environmental policy to economic policy and an overall strategy of 21st century global competitiveness (Cohen, 2011).

Clearly, climate change policy has evolved and progressed since the Clinton era, but just as clearly, it has yet to make the leap of progress at the level of the federal government, and many experts feel we need to avert the worst effects of a warming planet. The main explanation for this is that climate policy does not mesh well with the place-based nature of American environmental politics. Those environmental issues with grassroots support, ones that generate clear, sustained, and visible impacts felt at the local level, are more likely to achieve political salience and generate momentum for policy solutions. However, climate change is remote and distant, and its impacts are imprecise and based on mathematical models and projections. The major venue of climate politics is between scientists, corporations and politicians, and lobbying elites seasoned in Beltway politics. Furthermore, even though it is widely noted that comprehensive climate legislation would very likely generate net societal benefits outweighing the costs and that the lack of policy is harming the U.S. competitiveness internationally, the shift would be costly for select industries. The resulting job losses would be felt very strongly at the local level in the areas where they are sustained, and this issue, especially during a recession, is politically salient. This increases the political risks to individual politicians for pursuing a climate policy. Another interesting consequence of place-based politics on climate change policy is that nuclear energy, formerly a clean energy option favored by both President Obama and many Republicans, became a political non-starter after the 2011 nuclear crisis in Japan, reducing the options for a bipartisan consensus on renewable energy. As discussed above, the fear of nuclear catastrophe is acute at local levels, and the siting of new plants will be almost impossible given local land use politics. Local issues like jobs and land use win out over widespread problems like climate change.

The uncertainty inherent in science also serves to open up climate change politics to competing influences, controversy, and debate. Climate change projections and attribution, like most science, have at least some degree of uncertainty. This uncertainty can then be manipulated by those opposed to climate change policy, disputing the science while emphasizing the tradeoff between action on climate change and economic prosperity. In this way, due to the very nature of scientific knowledge, issues at the interface of politics and science can always be challenged. The basic psychological impulse to suppress or downplay information at odds with one's own political views, and to seek out information that confirms those views, is most certainly at work in climate change politics.

The politicization of climate science, which grows out of the basic uncertainty of scientific information and the complexity of the climate system, has contributed to a polarization around the climate change issue. Lacking clear localized effects, the place-based preference of our political system renders it difficult for climate

change to make the non-incremental leaps we have observed in some other environmental policy issues. However, as demonstrated by the history of U.S. climate change legislation, the United States has made strides on climate change over the past two decades, and it seems appropriate to characterize its evolution as a variant of "progressive incrementalism."

Climate change politics in the United States is one of the most contentious and ideological issues on the political agenda, with powerful interest groups mobilized on either side of the issue. A main aspect of the problem is the tradeoff between economic and environmental well-being, which is rooted in values. Rein and Schön (1993) argue that in this type of policy problem, the issue of framing becomes even more important than evidence (1993, 145). In policy debates, a frame is "a perspective from which an amorphous ill-defined, problematic situation can be made sense of and acted on," and usually integrates values, theories, and interests of the relevant political actors in addition to facts (Rein & Schön, 1993, 145). The way environmental problems like climate change are interpreted, beyond the fact of the problem itself, depends very much on an individual's setting and worldviews. This interpretation guides the decisions on what types of policy solutions (if any) should be adopted in response. Going forward, LCA studies would benefit from a more precise political understanding of this type of behavior, since it dictates the way LCAs are received by policymakers, politicians, and the public. A more nuanced appreciation of the interaction between science and politics would steer LCA applications away from the pitfalls of polarization, and toward a new consensus, however so slight that consensus might be. Recall Levin *et al.*'s pursuit of progressive incrementalism. Even if the first step toward climate policy is small, if arises out of genuine consensus, it can "lock in" more influential action down the road. That will require LCA practitioners to produce outputs in a format that anticipates and adapts to the criticisms of current detractors.

The climate science community is now starting to understand their role in this process of political action on climate change. A recent editorial in *Nature* (2010) acknowledges that the science community is in a "street fight" over climate science, and that, in light of the politicization of climate science, "scientists must not be so naïve as to assume that the data speak for themselves." (2010, 141). The editorial goes on to propose an enhanced relationship with the media, including media training and relationships with public relations firms (*ibid.*). This is in line with similar efforts within the science community, criticizing the "lack of scientific messaging" while calling for the development and implementation of "a serious communication strategy" so as "to effectively engage the public on this serious issue" (Romm, 2009, 23). Both the politics and the science around climate change seem grounded in political realities and poised to drive forward despite the current state of polarization of the issue.

Conclusion

In this chapter, I have examined the way that life cycle assessment plays into the environmental policy-making system in the United States. As we have seen, the incremental nature of policy-making, the place-based structure of the U.S. political system, and the role of scientific uncertainty often preclude the successful use of LCA in real-world decision making. I then showed how climate change politics fit into this template of environmental policy-making in the United States. The United States policy-making system does not easily respond to a problem such as climate change in a neat, linear, and rational format. Climate change as an environmental issue is widespread, diffuse, and indistinct, occurring at a future time with unknown magnitude. However, the political context in which environmental decisions are ultimately made favors issues that have clear impacts at distinct local scales. Furthermore, the uncertainties in terms of the effect of and the ideal response to climate change have created the conditions for highly contentious, partisan, and often values-based debates, and we see the median points of either camp drifting further and further apart. At times, this no doubt frustrates those who seek strong, comprehensive, and forward-seeking action. But it has been my contention throughout this chapter that the best strategy, for political scientists who are concerned about the future health of our planet as well as environmental scientists and practitioners, is to accept the constraints posed by the political structure and to devise new techniques that can bring about the intended outcome while operating within the given political context. That is what I suggested to improve LCA, with one major forward step being an explicit incorporation of economic considerations. Such a strategy may at first seem like a compromise, but in fact it maximizes the chances of ultimate success while focusing the efforts of the environmental community toward more productive ends.

I will conclude the chapter by discussing very briefly how a new and improved type of LCA, built on principles that accept the power and meet the requirements of prevailing political systems, could potentially begin to shift the environmental discussion in this country toward more fruitful ends. Practitioners of life cycle assessment must follow the changes within the political world and the climate science community and find ways to contribute to a reduced level of polarization in order to play a bigger role in climate change policy and beyond. So far, the use of scientific information has only further polarized the issue of climate change by politicizing the production and dissemination of science. But I have argued that progress on this issue requires a shared vision of the problem by all political actors. Thus, to participate more fully in this debate, LCA practitioners should keep this goal in mind and proceed to improve the methodology so as to enlarge the "formula" or shared definition. In my mind, the only way to achieve this is to address the critics and skeptics head-on. Perhaps LCA would be more successful if it explicitly incorporated economic assessment and demonstrated that environment-friendly policies would also be economy-friendly in the long run. I agree with Gregory A. Norris's critique of LCA, in which he argues that the "traditional separation of life cycle environmental assessment from economic analysis has limited the influence and relevance of LCA for decision making, and left uncharacterized the important relationships and trade-offs between the economic and life cycle environmental performance of alternative product design decision scenarios" (Norris, 2001, 118). By formalizing and institutionalizing economic considerations in LCA studies, LCA practitioners would undercut those who assail environmental policy on the grounds of it being too costly. In this way, advocates and policymakers seeking to implement certain environmental policies on the grounds that they would lessen greenhouse gas emissions could use LCA with economic analysis to justify the policy on economic grounds as well as environmental grounds.

The case of climate change demonstrates the difficulties of enacting climate legislation in the U.S. policy-making setting, but it also shows how LCA could be adapted to help reduce uncertainty and contribute to political action on climate change. In this chapter, we have seen that sometimes it is politics, not science, which impairs the current state of climate change politics. Ultimately, LCA could contribute to a process of reconciliation and consensus building between political opponents and in doing so would become very instrumental in U.S. climate policy.

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