

Priming the Pump with Grass, Trees, and Waste:

An Exploration of Biofuels Policy and Research Discourse and its Potential to Alter Living Spaces

Marcia S. Davitt

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Gary L. Downey (Chair)
Eileen Crist Patzig (Co-chair)
Daniel Breslau
James Collier
Ellsworth Fuhrman

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Abstract

Biofuels, a solar-sourced technology that can be processed from non-fossilized plant matter, have significant appeal as a means of securing a reliable, sustainable energy supply. They appear to offer significant potential by virtue of being harvestable from common plant life such as prairie grasses. I argue that a shared set of knowledge claims emerging from multiple energy/environmental institutions in Germany and the U.S. are linked by a shared set of assumptions. I characterize these claims as a “mainstream” discourse because together they function as a single powerful discourse that influences national policy and research priorities. In examining the potential material impacts of the discourse on regional and global habitats, I demonstrate the powerful *performative* capacity of the discourse. I also describe how this mainstream discourse perpetuates momentum along existing trajectories of at least three socio-technological regimes: agriculture, transport, energy. The practitioners (biofuels experts) of the discourse construct representations of the realities that form the basis of their research. I refer to these representations as maps because like a city map, they privilege some things while marginalizing others. These maps are then utilized as guides for intervening into the habitat in order to develop and implement biofuels. Implicated within the maps are practices that have the potential to reconstitute reality. For example, the mapping of a variety of plants as “energy crops” implicates practices generally associated with high-yield cash crops intended for trade on the global marketplace. The materialization of these practices will assimilate various plants, reconstituting them as bona fide energy crops, resulting in monocultured regional and global habitats.

I develop my argument by describing how knowledge production is regulated by the implicit rules that govern the discourse. This regulatory apparatus insures that certain types of knowledge as well as methods for producing that knowledge are privileged over others. I introduce several concepts—institutional platform, thought collective, biofuels practitioner—as

analytical tools to develop my argument and explain how the discourse functions. I demonstrate how perpetual recirculation of knowledge claims through publication, citation, conferences, workshops and task forces naturalizes these claims, giving them authoritative force. This force is evidenced in an increased performative capacity as well as a higher degree of discursive hegemony. I demonstrate the material effects of the discourse at the practical level of its deployment by introducing another analytical tool—*ground truthing*. Geographers and military reconnaissance personnel use ground truthing to describe the process of physically inspecting the lay of the land in order to determine the accuracy of the maps. With this tool, I demonstrate the potential of the discourse to reconstitute habitats and landscapes. Finally I propose changing the terms of mainstream energy discourse through practices intended to de-scientize and democratize the discourse through incorporating alternative expertises. This includes: a) moving away from corporate control of energy solutions by situating energy-systems decisions and ownership at the local community level, and b) improving the definition of systemic problems by transitioning away from knowledge production that privileges the detached “spectator” approach over the embodied, participatory approach.

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Chapter 1 - Introduction

1.1 Backdrop / Setting the Scene

Global pressure on the land has perhaps never been greater. Unrelenting increases in world-wide energy demand are shaping increasingly complex extraction practices developed to obtain difficult-to-access oil and gas. The technological processes and artifacts required to extract these unconventional oil/gas sources are resulting in unprecedented habitat destruction such as that witnessed in the Boreal forests of Alberta and the endangering of the foodshed coincident with the Marcellus Shale, “a geologic formation that arcs northwest from West Virginia through Pennsylvania and into New York state” (Royte, Dec 17, 2012, pg. 11). The highly toxic chemical inputs required for hydrofracturing to extract gas from this shale are permeating throughout the water and food supply, and although the effects of this contamination are clear enough, the nature of the fracking process makes it difficult to trace the pollutants to their exact source. Most notably these unconventional sources have an abysmal energy return on investment (EROI), i.e. they involve significantly higher proportions of inputs for the extraction of the raw material than do conventional oil sources (Heinberg 2013). More effort in the form of energy use and more habitat destruction in the form of chemicals released into the environment are required to extract ever-diminishing raw materials. For example, changing water-to-energy ratios reflect energy extraction and production processes that require the use of higher proportions of water for each unit of energy produced (IEA, 2012).

Added to these pressures is rising global demand for automobiles. As more countries engage in significant highway and urban construction projects, release of carbon into the atmosphere coupled with the loss of valuable carbon sinks threaten destabilization of the biosphere. Forests, agricultural land, wetlands, are under continual threat from the relentless expansion of concrete jungles that many embrace as symbols of progress, autonomy, and freedom even as they create inequitable political economies and unhealthy dependencies. The U.S. expansion of private automobile ownership now boasts more cars per capita than licenses issued to drive them (Jones, 2008). Evidence of the centrality of the automobile in the life of Americans and its growing centrality elsewhere is palpable. Millions of hectares of land are allocated each year to highway, runway, and urban construction projects with no signs of

relenting. The most frequently cited problem with respect to the growing numbers of automobiles on the road and planes in the sky are the issues related to carbon emissions.

The growing public awareness and concern with respect to greenhouse gas (GHG) emissions and climate change has contributed to increasing emphasis on renewable energy in general. Additionally, incidents involving oil spills, tanker explosions, and the ecologically degrading methods required to extract coal, oil, and natural gas from ever-farther reaches of the earth have contributed to the growing emphasis on biofuels. The 9/11 terrorist attack shaped existing concerns regarding depleting sources of petroleum and growing dependence on supplies located in volatile regions of the world. The government pronouncements, Congressional Acts, and agency regulations that followed on the attack also raised the sense of urgency regarding the need to transition the fuel economy to biofuels. Policy analysts call such events “windows of opportunity” because they enable policy entrepreneurs to push particular items to the top of the national agenda (Birkland 2005). Once an issue becomes a matter of national priority, the media play a pivotal role in distilling and circulating the related knowledge claims to a wider non-specialist public.

Enter biofuels, a solar-based technology that appears poised to take the renewable energy sector by storm. Interest in developing biofuels has existed since the beginnings of the automobile, with Henry Ford having designed the Model T to run on ethanol. A richly complex history of circumstances and events that ultimately decided in favor of oil demonstrates that the cheapness and availability of oil was only one among a number of influencing variables¹.

My aim, which I lay out in detail in the next section, is to highlight some of the most widely circulated biofuels research claims and policy proposals. I then demonstrate how the language and practices utilized by biofuels professionals in formulating these claims have considerable potential to shape ecological habitats, agricultural practices and socio-economic conditions.

¹ For a detailed account of these events refer to: Bernton, Hal, William Kovarik, and Scott Sklar (2010). *The Forbidden Fuel: A History of Power Alcohol*, new edition, Lincoln: University of Nebraska

1.2 A Background on Biofuels/Bioenergy

The term “biofuels” conveys an appealing association between life and fuel. Indeed, the appeal of this term lies partly in its stark contrast to fossil fuels which are sourced from dead fossilized matter. Often promoted as a renewable source of “stored sun energy,” biofuels are considered superior to fossil fuels in at least two respects: 1) the “stored sun energy” characteristic of plant life is more easily and quickly replenished after use (no need to wait millions of years for decomposition into densely-compacted carbon), and 2) the carbon cycle (in the ideal scenario) remains balanced since what is emitted during cultivation, extraction, processing, and utilization is restored through new growth and carbon uptake with the next season’s crop. The idea that humans can exploit sun energy quickly and reliably through the photosynthetic process holds considerable appeal when weighed against extracting hydrocarbons from dead matter that, once extracted, will take millions of years to replenish.

Some argue that the term “agrofuels” more suitably represents the process of standardization by which various plant life forms will be assimilated into the energy enterprise. They argue that the biofuels moniker misleads in that it implies that we can obtain our fuel supply from uncultivated vegetation growing within its own ecological niche (Biofuelwatch, et al, June 2007; McMichael, 2009). Furthermore, the agrofuels moniker more accurately conveys the likelihood that large agribusinesses will play a significant role in the production of these fuels. Crops cultivated by farmers for fuel rather than food are referred to as “energy crops.” For example, corn is cultivated in the U.S. for both food and fuel purposes, with farmers apportioning some of the land to food crop cultivation and some to energy crop cultivation.

Biofuels are produced from various forms of cultivated crops and other biological life forms such as forest and animal residues. Referred to as “biofeedstocks,” the most common biofuels inputs at this stage are the ethanol biofeedstocks—corn and sugarcane—and the biodiesel biofeedstocks (soybeans, rapeseed, and palm). These first-generation biofuels, due to their relatively low processing costs, are the low-hanging fruits of the fuel economy transition. Agricultural practices have been directed at cultivating these crops as food sources for many

years, and therefore transitioning a portion of the harvest to fuel inputs does not require significant investments in new technologies and practices. However, the same factors that make these particular crops advantageous in the short term can create new problems over the medium and longer term. Not only can this lead to regional food crises by creating an economic environment that makes it more lucrative for farmers to cultivate crops for energy rather than for food, but ecological degradation results from the agriculture practices—creation of monocultures and application of fertilizers, herbicides, pesticides—utilized for these export-driven cash crops.

Second-generation biofuels are processed from plant life or microbial life forms not utilized directly as either food or livestock fodder. Often referred to as “cellulosic biofuels” due to the cellulose and lignocellulose makeup of the biofeedstocks, the primary rationale for the development of these biofuels is their carbon-sequestration capacity combined with their capacity to grow without significant agricultural inputs. Taken together, these attributes contribute to a healthier, more balanced carbon flux, with CO² emissions significantly lower than for many of the first-generation biofuels. Because of their robust constitution, these plants are able to thrive on land not suitable for food crops; it is thus anticipated that they will not compete with food sources. Among the second-generation biofeedstocks considered highly advantageous are: perennial grasses and trees such as switchgrass, willow, and poplar; agricultural residues such as corn stover, bagasse (sugarcane post-processing residue), cow manure, and forest residue.

Much of the biofuels research underway involves assessing the performance of different biofeedstocks in terms of their environmental sustainability and their fuel yield. The environmental aspect of the assessment analyzes the carbon performance of the particular biofeedstock. For instance, assessments suggest that ethanol produced from switchgrass is much healthier for the environment in term of its impact on the carbon cycle. The life-cycle assessment (LCA) which examines the carbon emissions produced during cultivation, fuel processing, and fuel utilization, indicates that switchgrass ethanol emits far less carbon than corn ethanol. This is due largely to the capacity of perennial grasses to flourish without significant agricultural inputs (e.g. fertilizer, pesticides). Also, the perennial nature of the plant means the soil tilling required for annual re-cropping is avoided, thereby mitigating harm to the soil. An added advantage of perennial grasses: they produce significantly larger yields of fuel per hectare than some of the first-generation biofeedstocks such as corn and soy.

One of the most significant technical challenges lies with the processing of cellulosic biofeedstocks. Converting cellulose, an insoluble material quite resistant to breakdown, into sugar requires a complex and costly process. While many successful trials have taken place utilizing both biochemical and thermochemical conversion processes, the conversion process continues to be quite costly. Most recently, efforts are underway to use synthetic biology to design microorganisms that could break down the cellulose. Also in the research stages is the genetic engineering of the plant organism to produce more pliable cellulose.

Another technical challenge, particularly with respect to the existing auto fleet, with the exception of Brazil, is the so-called “blend wall.” The blend wall refers to the maximum amount of ethanol in a fuel mix that can be utilized in the majority of existing vehicles. The most common blend in the U.S. is E10 which stands for 10% ethanol, 90% gasoline. While some flex-fuel vehicles (FFVs) can handle a mix of E85 (85% ethanol), there are few pumping stations that offer this blend. This creates a catch-22 situation: on the one hand E85 is not offered by many pumping stations because the demand is too low, on the other, the lack of availability of E85 pumping facilities dampens the incentive to develop engines and/or purchase cars able to run on the E85 blend.

Brazil, due in part to strong government policies implemented in the 1970s during the first oil crisis, faces less of a challenge in this regard. A large proportion of the Brazilian auto fleet is able to utilize the E85 fuel mix. Germany relies mostly on biodiesel and the allowable mix is higher than the U.S. Previously pumps with pure biodiesel (i.e. 100% biofuel) were readily available due to a significant tax incentive in which biodiesel was exempted from the tax on regular diesel. However, the German government lifted this exemption when it came to light that the Treasury had sustained a considerable revenue loss. Once the exemption was lifted, demand for the pure biodiesel fell and many pumping stations ceased providing it (Verband der Deutschen Biokraftstoffindustrie, March 2, 2011; Interview 2010).

Added to the combustion engine technology challenge is the incompatibility of the existing fuel storage and transport/distribution infrastructure. The hydrophilic properties of ethanol cause pipe corrosion, making it impossible to utilize existing gas/oil pipeline infrastructure to transport it. The available alternative, the utilization of rail/truck transport for ethanol, adds significantly to the cost of the fuel.

Many third-generation or advanced biofuels are processed utilizing the same feedstocks as for second-generation biofuels with an additional step—hydrogen extraction—incorporated into the process. The goal is to develop hydrocarbons that resemble fossil fuels so that they can be utilized in existing combustion engine and pipeline distribution infrastructure. Often called “drop-in” fuels, these fuels are already being utilized by the U.S. Navy and some airlines. Drop-in biofuels are critical to these industries since redesigning aircraft engines to accommodate conventional biofuels would require significant economic investments and would take decades to complete. Third-generation biofuels also include additional biofeedstocks, e.g., landfill methane, municipal solid waste, and algae.

These developments surrounding the hoped-for transition of the fuel economy to biofuels, to which the foregoing serves as a brief introduction, echo the larger energy framework in its singular focus on scientific/technological solutions to complex societal and ecological issues. The topic of biofuels is timely because we have entered the “era of extreme energy” in which persistent denials of the reality of peak oil² are no longer tenable in the face of excessively costly (ecologically and socioeconomically) extraction methods like tar sands, deep-water drilling, and fracking.

1.3 Research Aim and Position Statement

My study addresses this two-part question:

- ❖ What characterizes the shared biofuels discourse (i.e. language and practices) emerging from institutions situated in Germany and the U.S.?
- ❖ What role does this discourse play in bringing about practices that have the potential to alter the *Lebensraum* (habitat or living space) of humans and other species?

I argue that many of the claims, prescriptions, and assumptions emerging from these institutions form a cohesive whole. Though not entirely homogenous, this cohesive set of ideas

² Peak oil is often misconstrued to suggest we have reached the stage where oil resources are about to dry up. In reality, peak oil refers to the *rate* at which oil can be recovered: “for every well there is an optimal rate at which oil can be extracted from the ground” (Greer 2013:7). Peak oil means we are on the downside of the extraction-rate curve. Indeed, today’s oil-extraction technologies, capable of extracting oil from difficult-to-access reserves, have been shaped by the reality resulting from peak oil: as the rate at which oil can be recovered from conventional wells declines, oil is being sought after in difficult-to-access areas.

tends to dominate biofuels policy and research. Assumptions and practices shared by biofuels experts lend cohesiveness to the diversity of their claims. The interweaving of the strands of a rope into a cohesive unit is what gives the rope its resilience. Likewise, the resilience and force of the discourse emerges from the interweaving of diverse knowledge claims into an intelligible unit (Crist 2013). I define a “knowledge claim” as any statement pertaining to knowledge produced by the professionals engaged in biofuels discourse. For instance, this statement—‘switchgrass has a robust rooting system that facilitates carbon sequestration’—qualifies as a knowledge claim. A policy mandating biofuel quotas is another type of knowledge claim. To emphasize the coherent, non-monolithic character of these claims and prescriptions, I utilize the phrase “loose confederation of knowledge claims.”

Since I too am situated within a particular discursive community with its own language and practices, the account that follows is obviously a situated perspective. From the outset, my analysis of biofuels research and policy has been framed by my concern that the belief in the necessity of economic growth will nullify many of the potential benefits, not just of biofuels, but of any other renewable resource. The association of progress or prosperity with economic growth is a dominant narrative that shapes human undertakings worldwide. The widespread belief in this narrative has played a significant role in human activities leading to irreversible damage to the biosphere. “Economic activity inexorably dissipates resources and increases the entropy (randomness, disorder) of the ecosphere” (Rees 2014:8). Scientists at the International Panel on Climate Change (IPCC) indicate that human-induced GHG emissions are changing the very composition of the atmosphere (Oreskes, Conway 2010).

We cannot expect to solve problems with the same mindset that brought them into being. A ‘cheap’ and very dense supply of energy has fueled the engine of economic growth for the past two centuries. The history of population growth makes it quite clear that the burgeoning growth in population, particularly that of the past couple of centuries, was stimulated by fossil-fueled industrial agricultural (Greer 2013; Wright 2004). We are now living in the age of “extreme energy” in which the “low hanging fruits” have been picked over and oil/gas extraction are more costly—ecologically, socio-economically—than ever before. The diffuse nature of all renewable energy sources means these sources will never be a true substitute for fossil fuels. So long as prosperity is associated with keeping the economic engine running at full tilt, biofuels, irrespective of their inherent merits, will ultimately lead to degrading extractive practices.

Renewable energy discourse aimed at finding solutions that will facilitate business as usual while allowing the problematic narratives to go unquestioned, will simply reinscribe the narrative while generating more harmful extractive practices. The design of biofuels/bioenergy technologies within the existing prosperity-is-growth framework will further degrade human and nonhuman living spaces, and those altered living spaces will impact the climate in ways we cannot anticipate.

While I rely upon the lexicon specific to biofuels in developing my case, I do not participate as a practitioner of biofuels discourse. Instead, I use my own standpoint (described above) as an analytic framework to expose and describe the silences in the discourse. I can claim objectivity in so far as my standpoint as a non-biofuels practitioner facilitates my capacity to discern what the practitioners are not likely to notice (Harding 1991). The spatial or standpoint question raised by Harding (1991) and Downey (2010)—“*Where* do I stand in all of this?” (Downey 2010:390)—refers simultaneously to two potentialities: constraining bias and expanded insight. Although my own standpoint biases me in a particular manner, that same standpoint can serve as the platform for insight into other perspectives.

As an “outsider” to biofuels expertise, my attention is drawn to those things that may escape the notice of seasoned biofuels practitioners. The question that my study addresses combined with my own socio-cultural standpoint will determine to a significant degree the form that my own representation of the discourse takes. Indeed, my analysis can be likened to a speech act in that my own depictions and representations have the potential to bring into being a different reality. For instance, my objective in perusing articles written by plant geneticists clearly differs from that of plant geneticists or biologists perusing the same articles. Though we read the same article, our differing standpoints and objectives ensure that we will likely notice different things. The scientists may wish to run experiments and are therefore chiefly interested in garnering the details of the experimental process. This differs markedly from my aim of highlighting knowledge claims and exposing the assumptions that inform them.

Finally, this is not a study *about* biofuels. Rather I bring the biofuels discourse into conversation with larger issues pertaining to broader energy and sustainability discourses. This study is a vehicle for exposing the influence that the economic growth framework has on human attitudes and approaches to the nonhuman world. Indeed, the phrase “priming the pump”—a

popular metaphor for economic stimulation—in the first part of the study title signifies the study’s chief concern in this regard. A double entendre, “priming the pump” refers to economic growth stimulated by service station gas pumps filled with fuel derived from grass, trees, and waste. I highlight the discourse’s particular biases, describing its potential effects on agricultural practices and ecosystems. While the scope of my analysis must be bounded for practical reasons, the project speaks to larger societal questions and concerns. I use biofuels discourse as an exemplar for highlighting the impact of economic growth as an unexamined framework that organizes knowledge production in particular ways.

In the section that follows, I define in more detail the particular discourse analysis approach I take as well as describing the conceptual apparatus that I use to facilitate that analysis.

1.4 Methodology

I conduct a discourse analysis using a conception of discourse that encompasses language, practices, and human agency, and that recognizes the role of material culture and power relations as factors that shape and are shaped by the discourse. I analyze biofuels policy proposals and research problems and findings cited in publications circulated by biofuels practitioners of several prominent institutions based in Germany and the U.S. I also analyze the knowledge claims that emerged during the interview process.

I develop my argument by describing how the discourse is governed. Because a discourse is regulated implicitly through accepted standards for conducting research, its governance is best characterized by observing the patterns, inclinations, and material effects of the discourse. I introduce several concepts (described in the following section)—circulatory scaffolding, institutional platform, thought collective, biofuels practitioner, endowments of circulation—as analytical tools to develop my case. I demonstrate how the perpetual recirculation of knowledge claims through publication, citation, conferences, workshops and task forces naturalizes these claims, giving them authoritative force. I introduce another analytical tool—ground truthing to describe the material implications of the discourse at the practical level

of its deployment. Ground truthing also reveals the role that material factors (e.g. sociotechnological systems) play in shaping the discourse.

I began by educating myself on biofuels, and this involved a broad inductive exploration by utilizing internet searches on generic terms like “biofuels” and “energy crops.” As I acquired a basic lexicon, I increased the sophistication of my searches, narrowing them down to more specific terms and topics. Eventually my analysis began to reveal which institutions and publications were the most prominent sites of biofuels knowledge production. I also began to discern a pattern of emerging themes with certain problem definitions, research questions, and knowledge claims recurring across a broad swathe of publications from a variety of institutions. I also noticed that most of the literature occurs within the past decade and that much of the focus is on second-generation or advanced biofuels.

In Germany my research got underway through faculty contacts at Technische Universität Darmstadt who referred me to people and institutions involved in biofuels. Using these contacts, I then engaged in a similar process to the one I was using for the U.S. As I became familiar with the literature and interviewed various practitioners, I was able to discern a pattern in the themes that emerged repeatedly, many of them the same as I was observing in the U.S.

In the process of analyzing these emerging themes, I discerned recurring patterns in their framing, i.e., the implicit assumptions that shape the distillation and presentation of claims. An important recurrent theme, for example, regards the availability of marginal land for cultivating energy crops like switchgrass that, with its robust rooting system, is able to thrive in arid soil; this theme seems consistently framed by the assumption that there exists general agreement over just what constitutes “marginal” land. In reality, the concept of marginal land is highly contested and involves complex issues of political economy and ecology.

Confronted with a growing plethora of publications and institutions, I narrowed my focus to the institutions that emerged as playing the most significant role in shaping biofuels policy and research. I also drew from the publications of think tanks, academia, and consulting groups where close connections between these and the primary agencies and institutions became obvious. For example, the IFEU (Institut für Energie und Umwelt) research institute in Germany does research for the Umweltbundesamt (UBA), and the U.S.-based National

Resources Defense Council (NRDC), an activist organization, engages in research utilized by the U.S. Department of Energy and the EPA. I also examined some mainstream media publications—e.g. The Economist, Scientific American, Spiegel, Klimaretter.info—because their role as distillers and populizers of discourse makes them particularly valuable indicators of which knowledge claims predominate.

I developed a more deductive and systematic approach to highlighting the recurrent themes by composing a set of categories—e.g. cellulosic biofuels, marginal land, land-use change, agricultural / forestry practices—into which I grouped the recurring knowledge claims (refer to Appendix A, Part I). I then utilized these to flag particular claims as I came across them in the publications. The grouping of claims into these categories gave way to an emerging pattern of broader themes which I outline below in the form of questions. These questions facilitate the mapping of ‘topographies’ (chapter two) of knowledge claims that cohere as a discourse particularly well-situated to organizing a world picture of energy/environmental issues confronted by society (Crist 2013; Downey 1998):

Bioenergy/Biofuels Rationale: What are the most frequently cited rationales for transitioning the energy economy to bioenergy and biofuels?

Biofeedstock Assessment: Which biofeedstocks are being proposed as biofuel inputs, and what are the pros and cons of each?

Sustainable Management of Bioenergy/Biofuels: What are the primary issues, concerns, and proposals with respect to the capacity to sustainably manage biofeedstock cultivation, extraction, and processing?

Commercialization of Bioenergy/Biofuels: What are the primary challenges hindering the immediate and full commercialization of second- and/or third-generation biofuels?

Each of the above themes consists of multiple claim categories, some of them overlapping into multiple themes (Appendex A, Part II). For example, the knowledge-claim category called “cellulosic biofuels” is addressed by at least three of the four themes. The value added by the themes is to emphasize differing aspects of particular knowledge claims. For example, addressing cellulosic biofuels within the *Biofeedstock Assessment* theme involves laying out the set of knowledge claims regarding the relative performance of each of the biofeedstocks, whereas addressing cellulosic biofuels within the *Commercialization* theme

involves claims centered on the economic and technical challenges involved in the breakdown of cellulose into starch or the challenges involved in transporting bulky biomass.

1.4.1 Scope of the Analysis

My decision to focus on the biofuels practitioners situated in Germany and the U.S. came about initially through a combination of practical realities and research opportunities. However, it has since become clear that these two regions have great potential to influence the direction of global biofuels policy, development, and implementation. The U.S. continues to wield significant global influence through institutions such as the World Bank, the International Monetary Fund, and the World Trade Organization as well as through multi-national institutions. Biofuels and bioenergy are likely to figure prominently on the agendas of all three of these institutions. Not only do biofuels figure prominently into Germany's national energy agenda, but Germany has a leading voice in the policies of the European Union, and is the EU's largest producer of biodiesel. Because so many researchers and policymakers representing German-based agencies and institutions work together with other European representatives on EU initiatives, including Germany in my analysis provides some insight into the discourse that prevails in the European Union.

Yet despite the validity of the rationale for selecting these countries, the regional provenance of the knowledge claims does not carry significant weight for the study at hand. While the political and economic clout of Germany and the U.S. obviously shapes the extent to which the discourse gets circulated, I deliberately refrain from attributing too much centrality in the analysis to these regions. My analysis aims at highlighting the shared claims that have (or are likely to have) the most significant material impacts, ecologically, socio-economically, and politically. Knowledge claims that undergo repeated circulation and distillation eventually break free from the regional institutional platforms from which they originated. I thus argue that the regional and institutional bases that define the scope of this study weigh far less significantly than the global reach of the discourse's material effects (i.e. the discourse's performativity). And while these effects will likely vary by region due to topographical and climatic variations, the power of the discourse to reconstitute reality according to the maps it constructs is a factor of its hegemonic depth and extent, not its regional provenance.

One frequently encountered discussion shared by the Germany- and U.S.-based discourses centers on the concept of “marginal” or “degraded” land. And although conceptually, marginal land takes on differing meanings in differing contexts, the general theme of using land designated as “degraded” (of little value) in order to cultivate certain varieties of cellulosic energy crops remains the same and raises a similar issue in all regions: who gets to make the judgment call regarding which land meets the criteria of “degraded” or “marginal” and who defines these criteria? In practical reality, some regions of the globe may suffer more social injustice issues through corporate land grabbing than other regions. Despite the vagueness or slipperiness of the term, the fact remains that discourse regarding marginal land is globally circulated and is likely to have material impacts.

While including Brazil or perhaps China may enrich my analysis, it would not change the focus on the knowledge claims made by experts who produce and exchange knowledge according to a shared set of assumptions and practices. This is not to say that there are no differences but rather a set of knowledge claims that, while not homogenous, tend to follow a similar trend. For example, first-generation biofuel feedstocks are different for U.S. (corn, soy), Germany (rapeseed), and Brazil (sugarcane), yet practitioners in all three regions emphasize the necessity of transitioning to more advanced biofuels in order to mitigate land-change issues, and they follow similar scientific protocols for assessing which advanced biofuels have the most promise.

Of interest to note within the context of this discussion is that the U.S. Department of Energy through its Oak Ridge National Lab and the University of Tennessee and the Chinese Academy of Sciences formed a China-US Joint Research Center for Ecosystem and Environmental Change in 2006. In 2008, a workshop entitled “Bioenergy Consequences for Global Environmental Change” was held in Beijing. In reviewing the articles that emerged from this workshop, I find that both the China-based and the U.S.-based workshop researchers share the same discourse as evidenced by the shared set of knowledge claims emerging from the articles. This does not change the fact that China will likely experience the material effects of the discourse quite differently than the U.S. or Germany.

In the three analytical chapters (3-5), I do not (nor could I) limit the scope of my analysis to any particular region. Where pertinent to the discussion, I may point out that some effects

may be experienced more palpably in certain regions of the globe. While impacts will surely differ by locale, the regional provenance of the discourse is not what will differentiate these impacts so much as the regional topography, climate, and socioeconomic conditions. To summarize, I limit the analysis of particular biofuels publications to biofuels communities of practice situated in Germany and the U.S., while my analysis of the effects of the discourse demonstrates that its materialization is not determined by its regional provenance.

As mentioned previously, I began the analysis of publications process by casting a wide net. But as patterns began to emerge, I zeroed in on a group of institutions, publications, and biofuels practitioners that emerged as playing a significant role in influencing knowledge claim production and circulation. The time span of the literature extends from approximately 2004 to the present. Circa 2004-2009 marks the beginnings of a period of prolific publication and lively discussion centered on biofuels and bioenergy that continues to this day. The passing of biofuels-related legislation in the U.S. and the European Union during this interval provided the catalyst for this proliferation of publications.

I conducted semi-structured interviews that consisted of several general questions to stimulate discussion while also allowing for additional questions to emerge during the course of the interview. Candidates for interviews came from two sources: practitioners who authored publications, and referrals made by practitioners whom I interviewed. Recruitment letters and interview questions (see appendix B) were modified and customized according to my knowledge of the individual's background and publications. While the overall theme of the questions—second-generation and advanced biofuels, carbon emissions, land-use change—remained the same, there were cases when I found it necessary to structure the questions differently. For example, the interview with an agricultural expert at an environmental institution based in Hamburg was structured differently than an interview with an electrical engineer at an automotive institution in Berlin. With the agricultural expert, the discussion focused on land-use change issues whereas with the electrical engineer it focused on the challenges involved in redesigning engine technology to for compatibility with liquid biofuels.

The interviews are intended to supplement the publication analysis. As might be expected, the practitioners I interviewed generally did not stray outside the prescribed bounds of their particular thought collective (next section). However, the informal nature of the interviews

facilitated the emergence of aspects of the conversation generally not observed in agency publications. While the publications tend to oversimplify by treating conjectures and best guesses as “done deals,” practitioners in an interview have the opportunity to negotiate meaning during the interview. For example, a couple of the interviewees openly discussed the hyperbole surrounding the supposed commercial readiness of second-generation biofuels, explaining that this was how the biofuel industry skills “lure” venture capitalists and policymakers into investing in and promoting an industry that may prove to be a risky venture.

A summer (2009) spent doing research at the Environmental Sciences Division of Oak Ridge National Lab (U.S. Dept of Energy) also informs this analysis. In this case, I collaborated with three biofuels practitioners—a mathematical ecologist, an economist, and a toxicologist—on devising criteria for selecting biofuels sustainability indicators. This research opportunity enabled me to assume a double role of participant-observer in the biofuels conversation. Not only did I participate directly in the production and circulation of knowledge claims, but I also gained special insight into the particular politics of knowledge claims that regulates the discourse at the U.S. DOE. My involvement in brainstorming and planning meetings and in editing and commenting on documents intended for circulation provided me with an insider’s firsthand experience of the contingencies surrounding the production of knowledge claims. I gained special insight into the process that transforms “science-in-the-making” to “ready-made-science” (Latour 1987) through my participation with the practitioners in the production, circulation, and distillation of knowledge claims.

In the following section, I introduce the conceptual tools that I utilized as an aid in analyzing and mapping the discourse.³

³ I use the mapping metaphor in two different instances: a) my own mapping of the biofuels discourse, b) the maps or representations discursively constructed by biofuels practitioners in the course of producing knowledge. Please note that all references to the mapping metaphor that occur in subsequent chapters refer to the latter case.

1.5 Analytical and Conceptual Tools

1.5.1 Discourse as a primary venue of knowledge production:

I utilize the term “discourse” to refer to the language and practices shared by biofuels professionals, whom I call biofuels practitioners. Practitioners construct representations from their research, and these representations, like maps, serve as guides to the terrain they represent.⁴ Two maps of the same city, designed with differing goals in mind, will look quite different. A map of Boston designed by a tourist bureau will bring out quite different features than a map designed by city planners. In each instance, the map designers have differing goals and assumptions and the maps they design foreground and background features of the city that reflect these goals and assumptions. In similar fashion, practitioners of a discourse privilege certain types of knowledge claims while marginalizing others. Certain features on these maps stand out due to their particular juxtaposition with de-emphasized features. Much as the flame of a candle glows more brightly when encompassed by darkness, the privileged knowledge claims emerge all the more saliently as a factor of the marginalized claims surrounding them. Indeed, privileged knowledge derives its meaning from its relationship to knowledge that is marginalized or concealed:

...to recognize what is absent is as important as what is present [...] the “unsaid of a situation” or “what has been left out” is as important as the “said,” because the “non-said” reinforces what is said. *Meaning is relational* [my italics]. Terms marked positively mean in relation to what is absent, unmarked, unspoken, or unsayable (Schüssler Fiorenza, 1999:80-81).

Because researchers’ maps can never be more than approximations to the reality they represent, the use of the maps to intervene in that reality is always fraught with some risk. The larger the spatial and temporal scale, the greater the risk of unanticipated consequences reaching dangerous tipping points of critical mass. The wider array of variables that enter the mix through increases in scale simply cannot be accounted for, managed, or controlled. Furthermore, practices implicated by the maps (re)inscribe the features of the maps into the landscape, reconstituting it in the process. The maps are projected onto reality and eventually, the reality begins to more closely resemble the map. An ongoing co-construction of maps and habitats can lead to a situation in which entire ecosystems are fully assimilated into the human enterprise.

⁴ I utilize the concepts of “map” and “representation” interchangeably throughout this study.

For a limited time these reconstituted realities may seem more malleable and amenable to human control, leading to premature assumptions regarding the efficacy of human interventions into complex ecosystems.⁵

Because assimilated habitats intermingle with and participate in entire ecosystems, human interventions can trigger severe states of disequilibrium. For example, mapping particular forms of plant life as “energy crops” implicates practices associated with high-yield cash crops intended for trade on the global marketplace. Application of the practices implicated by the energy crop map to switchgrass will (re)inscribe the map into the switchgrass organism, transforming it into a bona fide energy crop. Thus, plants mapped as energy crops will be fully assimilated into the energy enterprise. The participation of these fully-assimilated crops in a complex ecological niche subjects the entire niche and beyond to unanticipated emergent phenomena. Complicating the risks inherent in such situations is the impossibility of establishing conventional scientific cause-effect linkages (Sarewitz, 1996).

Discourses operate neither autonomously nor in a vacuum. Power dynamics, institutions, socio-economic conditions and interests, technological infrastructure, cultural norms and practices, and legal/regulatory frameworks play a significant role in shaping discourses. All of these factors, including the relationships that exist between them, are described by scholars variously as a socio-technological regime, system, or arrangement (Balabanian 2006; Collingridge 1980; Feenberg 2002; Hughes 1987). “Regime” most appropriately signifies a system that “limits individual autonomy and imposes a style of living over which individuals have little choice” (Balabanian 2006:21). The emergence of such a regime takes place over time with the institutionalization of processes, the expansion of a bureaucracy dedicated to maintaining the regime, capital investments (with their implied interests), and the solidification of relationships with shared interests.

The momentum generated by the development of sophisticated structures, the investment of interests, and institutionalized bureaucracy leads to path dependency or regime “lock-in.” Also referred to as the “psychology of previous investment” or the “sunken cost fallacy,” path

⁵ More on this in a subsequent project, but I believe that the illusion that humans can manage and control their surroundings arises from the vast sea of monocultured living spaces we have engineered. Hubistic ‘superman’ proposals (climate intervention/geoengineering schemes) aimed at manipulating atmospheric, stratospheric, and biospheric systems appear within human reach because our banalized living spaces increasingly mirror back to us our own creations. We are thereby fooled into believing that we really can be the ‘masters and possessors’ of nature.

dependency insures that all new investments and developments will be aimed at maintaining the existing regime (Greer 2013). At this stage, envisioning alternative pathways becomes difficult because so much is at stake in assuring that nothing destabilizes the existing regime (Collingridge 1980; Hughes 1987). In a phenomenon known as the “Coleridge Dilemma,” the incipient stages of technology development present many alternatives, yet the insight to choose the best alternative often does not emerge until a chosen alternative becomes institutionalized. However, by this stage a full-blown regime has emerged and so much is at stake in maintaining it that alternative trajectories do not even appear on ‘the radar’ (Collingridge 1980).

The discourses that operate within a socio-technological regime play a key role in generating the momentum that leads to lock-in. The biofuels discourse operates in at least three well-established socio-technological regimes—energy, transportation, agriculture—all of these interconnected through shared discourses, interests, and investments. The scholarship on socio-technological regimes does not emphasize the critical role played by discourse in shaping the regime and contributing to the “lock-in” condition. My analysis demonstrates how the biofuels discourse operates within these socio-technological regimes, facilitating their momentum along existing trajectories and contributing to their capacity to alter ecosystems. For example, agricultural practices emerging from the biofuels discourse would be implemented by institutions established within the agricultural socio-technological regime.

Although an analysis of these regimes is beyond the scope of this study, recognizing the role the regimes play in framing the discourse is critical to understanding how the discourse shapes change. It is framing that gives particular meaning to facts, statements, or claims, making them non-neutral (Gamson 1989; Kuypers 2009). As especially potent frameworks, socio-technological regimes organize our experience of the world in a particular manner. They suggest what is at issue, i.e., what we should pay attention to. “Frames are so powerful because they induce us to filter our perceptions of the world in particular ways, essentially making some aspects of our multidimensional reality more noticeable than other aspects” (Kuypers 2009:181). Framing renders facts, claims, or statements non-neutral by giving them a particular meaning (Gamson 1989). Not only does the socio-technological regime frame the discourse, but the discourse itself acts as a framework.

In the paragraphs that follow, I highlight but a few of the many existing theories of discourse and discourse analysis. While my rendition of discourse includes elements of all of these, I emphasize the governance or regulation of discourse as interpreted by social epistemologists (Fuller 2007) and by Foucault, both of which I expand on in the following discussion:

Discourse has multiple connotations depending on the context in which it is utilized, and its meaning has changed somewhat over time. David Howarth (2000) discusses the changes in the conception of discourse from something that referred mostly to language and/or text to a concept that is much more robust: “as the concept of discourse has been employed in the social sciences, it has acquired greater technical and theoretical sophistication, while accruing additional meanings and connotations” (3). Gillian Rose (2001) points out that discourses structure the way we approach the world:

Discourse refers to groups or statements which structure the way a thing is thought, and the way we act on the basis of that thinking. In other words, discourse is a particular knowledge about the world which shapes how the world is understood and how things are done in it (136).

A broadened rendition of discourse as the “practices that systematically form the objects of which they speak” (Foucault 1972:49) views the discourse as constructing subjects, objects, and the relationships between them. Objects cannot therefore be traced back in time to some primal origin on the basis of their existing interpretation or use (Foucault, 1972; Nietzsche, 2009). Nor can the past be defined in terms of the present (Butterfield, 1965). This type of analysis—one that does away with notions of a transcendental subject and recognizes that subjects and objects are constructed by discourse (Foucault 1980)—is referred to as a “genealogy”:

A genealogy [...] does not involve a presentist or teleological conception of history, in which the historian understands the past in terms of the present, or sees in the past the origins of the present. Instead, it begins with the problematization of an issue confronting the historian in society, and then seeks to examine its contingent historical and political emergence (Howarth, 2000:72).

A genealogical history, rather than asking, “where did biofuels come from?”, instead asks, “what convergence of events made the construction of biofuels and the facts surrounding them possible?” It defines objects “without reference to the *ground*, the *foundation of things*, but by relating them to the body of rules that enable them to form as objects of a discourse and thus constitute the conditions of their historical appearance” (Foucault 1972:48). A genealogy, rather

than approaching an object as a concrete *thing* with a history, approaches an object as something made possible by a confluence of historical *events* (Herrnstein Smith 2005).

The value of a genealogical analysis is that by destabilizing naturalized claims and inevitabilities, different and heretofore-unconsidered alternatives present themselves. A genealogy exposes the fallacy of “scientific *discovery*, the uncovering of a truth already there” (Herrnstein Smith 2005:49) in explaining a particular development. “In this way, the genealogist *discloses new possibilities foreclosed by existing interpretations* [my italics]” (Howarth 2000:73).

“Discourse analysis is interested in [...] how a particular discourse describes things (although the power of discourse means that it produces those things it purports to be describing), in how it constructs blame and responsibility, in how it constructs stake and accountability, in how it categorizes and particularizes” (Rose, 2001:150). Discourses, through repeated circulation of knowledge claims, black box or “stabilize situations of meaning” (Callon, Latour 1981:284-285 cited in Gottweis, 1998:19). Thus, unpacking a discourse involves prizing open these black boxes, disclosing the contingencies within, and destabilizing indisputable facts and inevitabilities.

Discourse analysis also demonstrates how practitioners (the people who ‘live’ in the discourse) are bound by certain constraints and how they operate within these constraints. Indeed, practitioners are *not* free to express anything they wish, not, that is, if they wish to maintain their professional status as practitioners of the discourse: “what can be said and what can be perceived to count as knowledge is very limited and occurs within certain very clearly delimited and recognized bounds” (Mills 1997:67). The regulation of knowledge production is of primary interest to social epistemologists who are taken up with the normative question: “*How should the pursuit of knowledge be organized, given that under normal circumstances knowledge is pursued by many human beings, each working on a more or less well-defined body of knowledge and each equipped with roughly the same imperfect cognitive capacities, albeit with varying degrees of access to one another’s activities?*” (Fuller 2002:3).

The concept “politics of truth” (Foucault 1997) refers to the regulation of knowledge production within the discourse. Practitioners must follow the prescribed (mostly implicit) practices for producing knowledge if they wish to have their claims legitimized by the discourse.

Truth, as rendered in this context, refers to a knowledge claim recognized by the discourse. In other words, acknowledgement by the discourse's practitioners that a claim can be legitimately pursued gives that claim authoritative force. For this study, I render Foucault's phrase as the "politics of knowledge claims" to avoid the confusion that may result from differing interpretations of the concept of truth. "Knowledge claim" refers broadly to research questions, findings, issues, concerns, representations, policy proposals or recommendations. Because the politics of knowledge claims often function implicitly, they can be discerned indirectly by asking questions such as: What type of statements qualify for research funding? Which claims will colleagues in the field be mostly likely to endorse? What types of research questions would be unlikely to receive funding grants?

The rules (i.e. norms, standards, accepted practices) governing the discourse specify which types of knowledge claims are acceptable and which assumptions cannot be questioned. Because these assumptions frame knowledge production and circulation, understanding how the discourse operates requires making the assumptions explicit. Discourse rules and assumptions exist in a reinforcing relationship: the rules make questioning the assumptions off limits even as the assumptions inform the rules. Practitioners of the discourse must adhere to these standards if they wish to obtain and retain the authority to speak (i.e., to produce and circulate knowledge claims). A variety of practices serve as regulators of the discourse:

Seen as a social practice, scientific knowledge production not only consists of philosophical and theoretical reasoning, but also of funding procedures and institutional arrangements. Questions about legitimate knowledge are negotiated in all of these areas of activity. Thus, when one kind of scientific knowledge production is systematically funded rather than another, this contributes to its legitimacy in practice. Accepting an article for a science journal, enlisting a text as course literature, choosing whether to make a patronizing or praising comment at somebody's seminar—all of these infinitesimal actions, and all of the conventions around them, are practical contributions to the negotiation of legitimate knowledge, sometimes explicitly framed as such, but most often not (Latour 1987) (Jørgensen 2010:318).

Richard Peet (2002) defines "The hegemonic depth of a discourse—its intensive regulatory power—[as residing] in its ability to restrict serious, 'responsible' consideration to a limited range of topics and approaches or, more generally, an ability to specify the parameters of the practical, realistic, and sensible among linked groups of theoreticians, policy-makers, and practitioners" (57). Hegemonic depth can be discerned by reviewing the conferences, workshops, and forums that practitioners participate in and also by noting the extent to which

they are cited and by whom (other practitioners and the institutions they represent). This restriction to the “practical, realistic, and sensible” as it appears from a particular vantage point, describes the governance or regulation of a discourse. Knowledge negotiation and production proceed according to norms (often implicit) and practices established by the practitioners. These norms (e.g. endorsed research methods) regulate the borders of the permissible, implicitly demarcating legitimate research pursuits from those pursuits considered beyond the pale of the reasonable and rational.

Hegemonic extent is defined as “the regulatory space of the discourse [and] comes from its ability to persuade or coerce others across broad swathes of territory, where practices would otherwise be conditioned by narratives, discourses, and theories deriving from greatly different interpretive traditions applied to diverse regional experiences” (Peet, 2002:57). The hegemonic extent of the biofuels discourse is precisely what makes the discourse’s regional provenance a tangential rather than a central factor in my analysis.

Knowledge claims are political in the sense that discourses are sites of contestation and struggle where certain knowledge production practices ultimately prevail over others. Knowledge claims continually vie for supremacy within and across discursive communities. Ultimately, some claims prevail over others and are widely circulated. Official publications give the impression of consensus within the institution. Distillation, a process of simplification that occurs with the circulation of claims, conceals the struggles over meaning that take place prior to publication. Through distillation, the claims shed all evidence of their moorings in contingent debate. “It is impossible to restate a claim without transforming it in some way, and for a variety of reasons, as scientific knowledge spreads, there is a strong bias toward simplification (that is, shorter, less technical, less detailed representations)” (Hilgartner, 1990:529). In effect, the traces of contingent “science-in-the-making” disappear and the claims stabilize as “ready-made-science” (Latour 1987).

Perhaps nothing better exemplifies this tendency to render contingency invisible than mainstream media. Often functioning as a distiller of the somewhat arcane discourse that circulates within the academy, popular media writers and reporters simplify the knowledge claims in order to reach a broader, less specialized audience. In the process of simplification, many complexities and nuances of the discourse get lost. Distillation decreases the bandwidth—

a factor of how much information gets transmitted through the pipeline—of the information presented. With repeated circulation and distillation, the bandwidth narrows, meaning that less information gets carried over from the original source. At this later stage of circulation, claims stabilize, forming a part of the received wisdom that informs the popular climate of opinion (Harvey 2005).

Norms that regulate knowledge production operate co-constructively with those knowledge claims that comprise the mainstream discourse. On the one hand, mainstream knowledge claims become “obligatory passage points” (Latour, 1987) that implicitly determine the standard for regulating knowledge production. On the other, those standards determine which knowledge claims will ultimately prevail. For example, the EPA- and EU-mandated life-cycle analysis (LCA) is a method utilized for producing knowledge about the environmental sustainability of particular biofuel feedstocks. The credibility of claims regarding the carbon performance of particular biofeedstocks rests on the employment of the LCA methodology, itself a knowledge claim given force by the discourse. And through continual recirculation, the LCA has become an “obligatory passage point” for biofuels practitioners who desire their claims regarding biofeedstock sustainability to receive merit. In actuality, the LCA continues to be contested due to what some practitioners view as its inherent limitations. However, what matters here is that LCA has force part of the discourse that legitimizes it.

The common thread that links the foregoing conceptions of discourse together is the idea of governance or regulation. Foucault’s emphasis on the role of discourse in constructing concepts and artifacts is particularly relevant to this study. “Biofuels” began as a discursively constructed concept, leading eventually to a biofuels artifact, itself constructed by the discourse. Both the concept and the artifact derive their forms from the way the mainstream discourse is governed or regulated. A social epistemologist might observe that “biofuels” is a product of the particular way in which “the pursuit of knowledge [is] organized” (Fuller 2002:3). Thus, governance of knowledge production plays a crucial role in the discursive construction of maps and artifacts utilized by practitioners to intervene into the material world.

Finally, the persuasive aspect of the discourse plays a critical role in its circulation and acceptance into the mainstream.⁶ Understanding the “persuasive force of an argument” involves considering the speech context, the speaker-audience relationship and the constraints placed on them by the [sociocultural] location of the discourse (Schüssler Fiorenza 1991:20-21). Language in this context is viewed not as reflective but as *performative*, something that “creates and shapes the symbolic worlds it professes to evoke and describe” (Schüssler Fiorenza 1999:93). Both “language and knowledge of the world are rhetorical, that is, they are articulated in specific situations, by particular people, for a certain audience, and with certain articulated or suppressed goals and interests in mind” (93).

In the end, the knowledge claims that predominate are not necessarily the best or the most accurate claims. The claims depend very much on their persuasive force, and that force depends in part on the support provided by institutional bureaucracies. With research funding from funding bodies like the National Science Foundation (NSF) growing increasingly competitive, the opportunities to launch trials of strength (Latour 1987) in support of claims that counter the mainstream discourse grow less promising. As the realm of research grows increasingly competitive, the trials of strength required to launch counter-claims are becoming increasingly costly. The NSF and similar prominent funding bodies have a significant influence on shaping the discourse. Reliance on research funding, be it an academic or corporate undertaking has a homogenizing influence on the discourse as the funding pipeline grows more constricted.

The *performative* capability of mainstream discourses—their capacity to bring a particular reality into being—is perhaps the primary rationale for unpacking and critiquing them. While performativity characterizes all discourses, not all discourses are ‘equal’ in terms of the material realities they may bring into being. Whether the material effects of a discourse lead to significant problems depends on the nature of the discourse, the extent of its reach, and the

⁶ What Shussler Fiorenza is describing is a rhetorical discourse analysis. While I am not conducting this type of analysis, the insights of this theologian aptly describe what I am after in this project. “Aristotle [...] defined rhetoric as the ‘power of discovering the means of persuasion in any given situation’” (Kuypers, King 2009:2). Part of understanding how a discourse functions is discerning what makes the knowledge claims persuasive and/or authoritative. This could consist of a combination of institutional reputation, practitioner credentials, and the particular audience to whom the claims are directed. “Rhetoric has both an informative and persuasive element. For example, you might want to persuade someone to take a class with a certain professor [...] in order to effectively persuade, you must first provide information in the form of testimony, examples, stories, definitions, and the like. In short, you must use other than mere assertions as your arguments. In this sense, rhetoric involves the proper interpretation, construction, and use of supporting materials to back assertions and gain audience acceptance” (Kuypers, King 2009:4). My analysis involves highlighting and interpreting the elements of the discourse that give knowledge claims authoritative force, i.e., that make the claims persuasive.

regions and populations impacted by it. Discourses construct subjects and objects, but even more critically they organize “the perception of a world picture (past, present, and future) through a set of ideas and prescriptions” (Crist 2013:140). Thus, multiple discourses that share a cohesive set of knowledge claims organize perceptions and worldviews that permeate mainstream thinking. In a sort of feedback loop, these worldviews and perceptions play a double role as the regulatory apparatus (politics of knowledge claims) that practitioners of the discourses must comply with in order to have the authority to speak.

I employ the analytical tools described below to explore these questions: How does the discourse persuade? How does it distill claims, distancing them from their contingent provenance? How do competing knowledge claims get resolved? What is the “natural way of things” according to the discourse? (Rose, 2001:154).

1.5.2 Biofuels Practitioners – Agents of the Discourse

Those who engage in the language and practices of the discourse, I refer to as “biofuels practitioners.” These practitioners—scientists, engineers, social scientists, policy experts—conduct biofuels research and/or policymaking. Linking them together are the institutions that employ them, and the conferences and forums in which they exchange knowledge. While I value the basic premise of the genealogical approach—decentering the transcendent subject of Western thought (Foucault, 1980; McCarthy, 1990), I believe with McCarthy (1990) that a middle ground between a decentered transcendent subject and a fully autonomous agent is conceivable. The biofuels practitioner is a socially situated identity that diverse types of professionals assume as they produce and exchange knowledge: “each disciplinary discourse produces the socially situated identities professionals take on and prescribes the kinds of activities in which they will engage and, ultimately the kinds of knowledge they will recognize, value, and produce” (Greckhamer, 2008, 311).

I find Fleck’s (1979/1935) conception of the *thought collective* a useful way to represent this group of practitioners exchanging and producing knowledge about biofuels. I render the concept somewhat more loosely than Fleck who envisioned a thought collective as representing single disciplines. However, having considered this concept alongside the concept of a

community of practice⁷, I find that the thought collective—“a community of persons mutually exchanging ideas or maintaining intellectual interaction” (Fleck, 1979/1935:39)—more suitably reflects my own understanding of an epistemic or discursive community.

For example, Greckhamer describes a discursive community as one that “shares a disciplinary discourse, which is instrumental in constructing the members’ world through language, interactions, symbolic systems, technologies, and *distinctive ways of thinking and believing* [my italics] (Gee, 1999)” (2008:311). The reference to “distinctive ways of thinking and believing” resonates with Fleck’s concept of a *thought style* which he describes as a “particular method of cognition” influenced by “the existing fund of knowledge” (Fleck, 1979/1935:38).

The practitioner positions are held by scientists, engineers, policymakers, etc. who engage in some aspect of biofuels research, implementation, and/or policymaking. Their expertise spans multiple disciplinary areas, e.g., landscape ecology, hydrology, economics, energy policy, sociology, agriculture, plant genetics, physics, mechanical engineering, biochemical engineering, chemistry, biology. Those participating in a thought collective exchange and produce knowledge according to a shared set of assumptions, most of them implicit. The thought collective with its shared thought style is what weaves the variegated strands of knowledge claims into a common discourse whose resilience has material effects.

Various biofuels practitioners often participate in the same forums, e.g., German scientists and engineers attend E.U. energy policy forums. Researchers, e.g., agricultural economists are often employed by policy think tanks (cite example) and both policy experts and researchers are employed by government agencies, e.g., U.S. Department of Agriculture (USDA), Environmental Protection Agency (EPA), either directly or through outsourcing to other firms. Government agencies rely on research institutions and Think Tanks to provide them with research findings that inform policymaking. Additionally, researchers in both U.S. and

⁷ A “community of practice is a group of people who share an interest in a domain of knowledge, for instance how to do open-heart surgery [and] together they develop a set of approaches that allow them to deal with this domain successfully” (De Cagna, 2001, 7). Wenger and Snyder (2000) describe communities of practice as, “groups of people informally bound together by shared expertise and passion for a joint enterprise [who] share their experiences and knowledge in free-flowing, creative ways that foster new approaches to problems” (139, 140). Rivera (2011) describes the community of practice as a “group of individuals that are held together by informal relationships through which they share identity, unity of purpose and meaning [and who] share experiences within a particular domain of knowledge [...]” (Rivera, 2011:102).

Germany are often called upon to participate in policy forums and/or to contribute to the policymaking process in an advisory capacity.

Experts of various backgrounds develop identities as biofuels practitioners with the aid of a boundary object. Biofuels functions as a boundary object that facilitates knowledge exchange by establishing “a shared syntax of language within which individuals in different communities can represent their knowledge” (Star, Griesemer 1989:72). The biofuels boundary object makes possible the negotiation of knowledge between experts grown accustomed to the symbolic universe established within their own specialized disciplines (Fox, 2011; Star, Griesemer 1989). Biofuels as both a conceptual and artifact boundary object serves as the locus for the acculturation and identity formation of a biofuels practitioner.

As part of my analysis, I demonstrate how prominent biofuels practitioners have the authority to speak⁸ within and on behalf of their thought collective. I do this by reviewing: a) the practitioner’s institutional base or platform, b) how they are situated within the institution, c) the network of other institutions and biofuels practitioners they are associated with, d) the frequency with which they are cited by other publications.

1.5.3 Circulatory Scaffolding

The production and circulation of knowledge claims is facilitated by what I call circulatory scaffolding—institutional platforms, practitioner credentials/prestige, venues (e.g. journals) of publication). Scaffolding within this context is most suitably rendered as “a raised wooden platform on which plays are performed...” (World English Dictionary). The raised platform *supports* the performers while *framing* their performance. Perhaps most noteworthy about the scaffolding is that it *recedes into the background* as the drama unfolds. Likewise circulatory scaffolding, in addition to providing the supporting structure that gives force to the knowledge produced by practitioners, frames the knowledge claims in a particular manner. Through recirculation, the claims shed their moorings in contingency and contestation, are distilled into more simplified statements, and the scaffolding that supports them recedes into the background.

⁸ The “authority to speak” within the context of this study always refers to the authority practitioners have to produce and circulate knowledge claims.

Discourses require an institutional base that confers force and legitimacy to both the claims and the practitioners that circulate them. By institutional platform, I mean the agencies, departments, and corporations that facilitate the circulation of knowledge claims through their supporting administrative functions. The Environmental Protection Agency in the U.S. and the Umweltbundesamt in Germany are examples of influential institutions that provide a platform for biofuels discourses. Although institutional platforms provide them with resources, capital, and expertise, for producing and circulating statements, thought collectives are not necessarily defined by institutional boundaries. Thus, a practitioner working for the EPA and another working for the World Resources Institute may actually belong to the same thought collective though they each rely on a different institutional platform from which to produce knowledge. Such institutions also play a critical role in perpetuating the momentum of socio-technological regimes along particular trajectories.

Each of these institutions employs their own biofuels practitioners as well as relying on other agencies and institutes for expertise. Of course, the discourses that reside within these institutions shape the identity and character of the institution itself. The point here is that some institutions have more influence on policy and research agendas than others. My study focuses on several of the most influential institutions in both nations. Other institutions that may or may not be officially affiliated with the predominant ones demonstrate implicitly through recirculation of knowledge claims from the predominant institution that they share these claims, and are therefore part of the same discursive community.

Yet more scaffolding is provided by the “endowments of circulation”—educational credentials, work experience, network of associates, number/types of publications, reputation—possessed by each practitioner. These endowments work hand-in-hand with the institutional platforms where practitioners are based: on the one hand the institution seeks out practitioners with strong endowments, on the other, a significantly endowed practitioner can extend the reach and influence of an institutional platform.

1.5.4 Ground Truthing

Ground truthing is the metaphor I have chosen to describe the assessment of the maps⁹ constructed by the biofuels thought collective. Ground truthing a discourse is an effective way to evaluate its material effects. On the one hand, this involves assessing the biases contained in a map and how these may impact the reconstitution of the terrain they represent. On the other, it requires assessing the implicit assumptions that inform the construction of a map.

Through ground truthing, I demonstrate that maps have material consequences. They serve not merely as guides to the terrain but also lead to the reconstitution of the *Lebensraum* through the practices they implicate. A discourse *performs* in that the maps that represent reality implicate practices that human agents then implement. The “energy crop” map encompasses switchgrass and other plants. In constructing this map, practitioners universalized selected particularities of the plants on the basis of the goal—biofuels inputs—for their use. The shared thought style facilitates the process of determining which particularities will be most suitable to the biofuels enterprise. The repeated application of practices implicated by the maps will lead to the *assimilation* of plants into the energy enterprise, transforming them into bona fide energy crops.

Ground truthing is a GIS¹⁰ concept that refers to the *in situ* assessment of the remote sensing images (i.e. maps) produced by satellites. Among other things, remote sensing images are utilized to assess the ecological conditions of particular regions, e.g., to monitor changes in the condition of the Brazilian rainforest. “Training” satellites in the construction of images based on the reflectance spectrum is a complex process involving complicated algorithms used to create clusters of reflectance pixels. Prior to this, landcover classifications must be determined and these are based on culturally-situated interpretations. Attributes considered relevant to a particular landcover in one context may be considered irrelevant or as belonging to another

⁹ Maps within this context are to be construed broadly as any depiction or representation of aspects of reality. This includes categorizations and/or classifications such as “energy crops” or “marginal land”, etc. Not unlike geographical maps, the maps that form the subject of this critique demarcate a particular territory. For example, “energy crops” is a map that encompasses perennial grasses and trees, corn, rapeseed, etc ... all plant life forms considered by practitioners as suitable biofuel inputs. *Please not that I use “maps” and “representations” interchangeably throughout the study.*

¹⁰ A Geographic Information System (GIS) is a complex technological tool utilized in many areas (geography, epidemiology, urban planning, conservation) that facilitates the spatial representation of particular data sets. For example, a GIS can be utilized by epidemiologists to analyze the regional factors that may explain the prevalence of particular diseases, and by urban planners in determining the optimum structural layout of a particular municipality.

landcover type within a differing context (Maddock 2009; Robbins 2001; 2003; Robbins, Maddock 2000).

For instance, locally-situated groups in a rainforest region may classify forest cover according to five or six quite different types of landcover, whereas state forest administrators may group all of these under a single forest-cover classification (Scott 1998). However, “in adopting and codifying the forester’s notion of forest, other forest-like coverages, each with their own local names and categories, are either collapsed with this invasive canopy cover into a generic category, or are excluded altogether” (Robbins 2000:295). In other words, the map of the forest cover is constructed by universalizing the particularities most valued by forest administrators. Any attributes existing outside the standardized forest canopy are deemed irrelevant to the goals that frame the classification.

In remote sensing, on-location geographers locate the area or object in question to determine whether the reflectance map produced by the satellite aligns with the *in situ* reality. This process is important for two reasons: 1) to determine the accuracy of the classifications that geographers formulated beforehand, and 2) to ascertain how accurately the satellite has been “trained” on the landcover types, i.e., did the satellite create the appropriate clusters of pixels on the basis of the classification algorithms? Based on the *in situ* analysis, geographers may find it necessary to either modify the classifications (note that this would involve a *reinterpretation* of the landcover) or to recalibrate the satellite.

Just as satellites are “trained” to produce maps of the landscape according to a predetermined classification system, so too, practitioners construct maps of reality according to a predetermined set of standards (the thought style). All such maps are limited in at least these two respects: a) they are partial depictions of reality constructed within particular socio-cultural contexts and according to preordained goals, and b) they are static, frozen in time, while the realities (in this case living organisms) they represent are dynamic and changing. Every map privileges certain aspects of the terrain it depicts while marginalizing or concealing other aspects. The purpose for which the map is intended clearly has a bearing on which aspects of the terrain take precedence over others.

Note that the maps may eventually become ends in themselves. Increasingly endorsed as an efficient land-management tool, the GIS maps can lead to the reconstitution of the landscape.

Particularly with respect to forest management, this reconstitution homogenizes the land cover, making it easier and less costly to manage through the use of remote instrumentation:

...landscapes are increasingly recreated to fit the demands of the technological optic. This process of “reverse engineering” can actually create self-fulfilling landscapes where, over short periods of time, land covers come to match the categories of planner’s imaginations, and so vindicate the accuracy and effectiveness of GIS and allied information tools (Robbins 2003:236).

Analytic Process: I begin by characterizing the circulatory scaffolding that supports the production and circulation of knowledge claims: the institutional platforms, task forces, committees, conferences, etc. I then introduce the biofuels practitioners who have emerged as having the most significant circulatory endowments with which to shape the biofuels discourse as well as to circulate claims representative of the discourse. I describe how these practitioners are situated within the discourse; this involves characterizing their particular endowments of circulation and how/why they are accorded the status of prominent biofuels practitioners.

I demonstrate how prominent publications can function as flagship publications that have extensive circulatory reach due to the strength of the institutional platforms authorship, citations, funding sources, etc. In analyzing statements made in publications, the source of the publication along with its authors and the institutions they represent are critical to determining whether or not particular statements have the requisite recognition as legitimate knowledge claims. These questions inform this aspect of the analysis: which institution(s) initiated and/or issued the publication? Which institution(s) do the authors represent, i.e., on whose behalf do they speak? Which institutions or funding bodies sponsored the publication?

I then lay out the knowledge claims that give rise to the contours of a mainstream discourse, using the dominant themes—bioenergy/biofuels rational, biofeedstock assessment, sustainable management of bioenergy/biofuels, commercialization of bioenergy/biofuels—that emerged during my analysis and which I introduced in the methodology section. For each theme, I draw attention to the implicit assumptions that inform the claims and shape the construction of the maps. Exposing implicit assumptions brings light the rationale behind the privileging of some claims over others. Here are some questions that inform this part of the analysis:

- What factors make possible the (re)circulation of some claims to the point where they become “obligatory passage points” (Latour, 1987), i.e., those claims that all practitioners are obliged to embrace if they wish their own claims to be legitimized by the discourse?
- Which issues can practitioners legitimately raise without fear of reprisal or loss of credibility?
- How can the silences on some issues be accounted for, and what is the meaning of the relationship between what is explicitly stated and that which is not stated?

Because the rhetorical aspect (persuasive character) of a discourse plays such a critical role in establishing the predominance of particular knowledge claims, I demonstrate the power of suggestion in the rhetorical juxtaposition of images and catchy phrases and titles. This tactic is often utilized to suggest particular associations, e.g., an association between biofuels and socio-economic health and prosperity.

1.6 Project Significance

In reference to vast socio-technological regimes that become ends in themselves, Lewis Mumford (1964) remarked that “life cannot be delegated.” He was referring to the state of affairs in which people’s lives are devoted to the maintenance of a bureaucratic machine rather than to human development. Mumford understood that the principles of democracy are either enhanced or inhibited by the technologies a society develops and adopts. Feenberg (2002) likewise sees the most insidious threats to democracy embedded within technological designs: “The values of a specific social system and the interests of its ruling classes are installed in the very design of rational procedures and machines even before these are assigned specific goals” (14-15). This study showcases discourse as a critical component in perpetuating the momentum that can lead a socio-technological regime into a state of lock-in. Counter-hegemonic discourses, if they reach critical mass, supply the resistant forces that inhibit momentum and destabilize the regime. Even the institutionalization of bureaucracy and the enrollment of new alliances and interests that strengthen a socio-technological regime operate via discourse.

This project contributes insights into the problems associated with relying on the dominant form of epistemology to address issues of political economy. Scientists will be the first to acknowledge that values do not enter into their research proposals and many do not see

this as a problematic omission. Bodies that implicitly govern knowledge production (e.g. the National Science Foundation) through the granting of funding focus solely on the potential instrumental value of an endeavor. In other words, the expectation of an “end product” dominates the proposal and review process. A related insight that this study draws attention to is the tendency to scientize (reduce problems to technological terms). Defining a problem within this context becomes a matter of reducing it to a matter resolvable through scientific and engineering approaches. Thus, while proposals for technological “silver bullets” abound, the structural issues of which environmental degradation and energy demand are merely symptomatic are left to fester.

The study has important implications for conventional approaches to policy and research. It demonstrates that decisions that appear to be merely a matter of technological preference are in fact value-laden choices that *normatively* shape the horizon of future possibilities. Policy and research efforts are usually invested in symptom mitigation rather than in investigating root causes. Because symptoms are usually quite visible, their mitigation can make a palpable difference. In societies in which the visionary horizon does not extend beyond the next election and/or stock report, symptom mitigation can shape significantly the turn of events.

Unfortunately, symptoms can quickly turn into ‘red herrings’ that deflect attention from root issues grounded in the core values of cultural narratives. Addressing symptoms¹¹ without the proper regard for core issues can lead to: a) premature triumphalism and complacency, perhaps best expressed as “out of sight, out of mind”, and b) a compounding of the real problem as the short-term fixes integrate with a complicated mix of unaccounted-for variables, exacerbating the original problem. The boundary between problem and solution grows increasingly fuzzy, and determining whether or not the latest solution may have exacerbated the original problem and/or brought new problems in its wake can turn into a bit of a ‘crap shoot’.

¹¹ This is *not* to say that symptoms should not be addressed at all. There are situations in which mitigating symptoms prevents a condition from worsening. However, just as the prevalence of pharmaceutical “solutions” to health problems has shaped a propensity for clinicians to prescribe drugs rather than work with people to change health-negating attitudes and behaviors, so to in the socio-economic arena, the availability of technological innovations increases the propensity to turn to these as permanent solutions to problems that are rooted in societal values and structures.

1.7 Summary of Chapter Contents

Chapter 2: The Penumbra of an Emerging Discourse:

In this chapter, I outline the contours of an emerging mainstream discourse that, while comprised of multiple perspectives, shares a common thought style. The penumbra or shadow of the discourse emerges in the process of analyzing the trends and patterns of knowledge claims. Here I lay out the claims and observe emerging patterns, while in the three chapters that follow, I critique the implicit assumptions and frameworks. Using the concepts of circulatory scaffolding, institutional platforms, thought collective, and biofuels practitioners, as analytical tools, I show how a particular pattern of shared knowledge claims forms the contours of a dominant discourse that permeates the mainstream of biofuels policy and research. A shared pattern of issue framing across a wide spectrum of publications and practitioners links diverse and complex issues to a common thought style. That means that a common regulatory apparatus (politics of knowledge claims) governs the way biofuels claims are produced and circulated. The circulatory scaffolding, held together by shared assumptions, also contributes to the dominance of certain practitioners and institutions.

These questions inform this part of my analysis: 1) Which publications have significant circulatory reach and what institutional platforms accord their practitioners the right to speak?; 2) Which single publications or articles are cited the most extensively, and by whom are they cited?; 3) What are the primary factors involved in continued recirculation of particular knowledge claims?; 4) For academic publications in particular, what kind of institutions are listed as providing the funding for the research and/or what institution(s) is the academic platform of the authoring practitioner(s) affiliated with?; 5) Which practitioners have significant endowments of circulation?

Chapter. 3: Ground Truthing I: The “Standing Reserves” of Biofuels Deployment

This chapter initiates the three-chapter section in which I trace and critique the material effects of the discourse. Utilizing the concept of *ground truthing* I show how the maps (i.e. representations) produced by the discourse are limited in their capacity to accurately depict the

realities they were constructed to represent. I critique the potential material effects of the discourse. As stated in chapter one, ground-truthing involves assessing the maps constructed by biofuels practitioners. The critique that follows highlights the potential impacts of the discourse on agricultural practices, ecosystems, and socio-economic conditions. Ground-truthing demonstrates the *performative* potential inherent within the discourse. I discuss the plants and organisms intended as raw material for biofuels processing, describing how the maps representing them can lead to their assimilation into the energy enterprise. The discourse *performs* through this domestication and assimilation of plants into human projects. Additionally, I critique the unexamined frameworks (or assumptions) of the thought collective since these play a critical role in shaping construction of the maps. By describing what the maps privilege and what they marginalize, I shed light on these implicit assumptions.

Chapter 4: Ground Truthing II: Awash in a Concrete Jungle:

In this chapter, I take up the research discussion centered on energy crop cultivation and potential impacts on the land within the context of a transport socio-technological regime that requires increasing amounts of concrete-and-steel infrastructure worldwide. The knowledge claims and problem definitions of biofuels practitioners are framed by this self-evident given: the growing global demand for automobile and airport infrastructure. This demand, one which poses a serious threat to landscapes and biodiversity worldwide, is never seriously problematized by the mainstream discourse. This seems bafflingly at odds with the efforts aimed at insuring that energy-crop cultivation does not bring about adverse land or biodiversity degradation until we consider the central role that living spaces play in framing the discourse.

I also address the inconsistencies that arise from promoting biofuels as a stimulus to developing rural economies on the one hand, while the global expansion of concrete jungles proceeds unabated on the other. The injustices created by this expansion threaten to degrade and impoverish the habitats of many of those same people who are supposed to benefit from biofuels. Indeed, simply replacing petroleum with biofuels will not address the social justice issues raised by a transport infrastructure that places unfair burdens on some of the most vulnerable groups in societies across the globe.

Chapter 5: Ground Truthing III: Problematizing the (Energy) Consumption Ethos

Buttressing the thought collective's shared system of knowledge claims is the belief in economic growth and the inevitability of increasing global aggregate energy demand. Biofuels discourse is framed by mainstream energy discourse which does not question economic growth and treats energy demand as an untouchable independent variable. This growing energy demand is bound up directly in the perpetual cycle of production and consumption that keeps ensuring continuing economic growth. While energy consumption is in part addressed through innovations that decrease per unit energy intensity, these do not address the problematic ethic of consumption that is gaining a foothold in a growing number of regions across the globe. The fact remains that aggregate demand is on the increase and shows no signs of abating. Countless reports by the International Energy Agency and other agencies provide statistics and graphs that cite this growth, yet there are no indications, with the exception of those cited by contesting discourses, that the increasing demand presents a problem requiring serious consideration.

The presumed necessity of increasing energy demand is itself framed by the Western progress myth that equates economic growth with progress. The use of Gross Domestic Product (GDP) figures as indicators of the 'health' of a nation testify to the prevalence of this myth. An unproblematized rising energy demand will exacerbate the issues raised in chapter 3 regarding the redirecting of plant life and land to new purposes. And since biofuels will be unable to meet this growing demand anytime in the near future, unconventional sources of petroleum that require extremely damaging and highly toxic extraction practices (e.g. fracking) will continue to be sought after, posing yet more threats to highly vulnerable populations and ecosystems. Perhaps no issue better illustrates the inadequacy of the problem as defined and framed by practitioners of the mainstream discourse.

Chapter 6: Beyond "Trickle-Down (T)ec(h)onomics": Toward a New Imaginary

In this chapter I begin by summarizing the primary contributions of my study and the broader issues that the study addresses. I then provide a rough sketch of what I see as some of the essential ingredients to charting an alternative pathway to the existing trajectory. I

emphasize the critical necessity of developing a new imaginary in combination with meaningful practical steps that hold the promise of shaping new patterns of thinking. The changes I propose are best summed up by these actions: *revisiting*, *revisiting*, *reconceptualizing*, and *reconnecting*. I conclude with an epilogue consisting of a summary of further questions that emerged from this study.

My critique in this study has given rise in particular to these further questions: How do decisions about complex technologies such as energy infrastructures actually lead to de facto normative choices about the future shape of society? What structural or institutionalized biases inform the current process? Whose (types of people) voices are heard and who is not at the table? Who qualifies as an “expert” and who gets to define these qualifications? How has reliance on experts lead to an institutionalized bias that automatically excludes alternative expertises?

Chapter 2: Penumbra of an Emerging Discourse

In this chapter, I outline the contours of an emerging mainstream discourse that, while comprised of multiple perspectives, shares a common thought style. The penumbra or shadow of the discourse emerges in the process of analyzing the trends and patterns of knowledge claims. In part, this penumbra is visible in the themes (outlined in chapter one) by which I frame the description of the knowledge claims.¹² Here I lay out the claims and observe emerging patterns, while in the three chapters that follow, I critique the implicit assumptions and frameworks.

Patterns and trends in the claims provide clues to a shared thought style that organizes and regulates the production of knowledge in a particular way. One such pattern emerges in the collegial associations established among prominent biofuels practitioners from differing institutional settings. These practitioners exchange knowledge as members of various international forums and through their citations of one another's research. The recurrence of the same practitioners in the authorship and/or the citations of biofuels publications points to a common thought style.

Often claims are deliberately distilled for the purpose of convincing and persuading a non-practitioner audience. The executive summary, a document written to “play to the gallery” to a certain degree, is a common venue of distillation. This summary accompanies many government agency publications frequently containing hundreds of pages of technical details and experimental assessments. Non-practitioner policymakers and politicians, often under pressure to move quickly, require a distilled presentation of claims that they can then use to convince and persuade their own constituencies.

Particular policies, regulations, and Congressional Acts are best thought of as knowledge products of the discourse. Policies such as the EU Renewable Energy Directive (RED) and the U.S. Energy Policy Act of 2005 and the American Recovery Act (ARRA) of 2009 are prescriptive knowledge claims that not only continue to shape the discourse that gave rise to

¹² These themes/questions are: 1} Bioenergy/Biofuels Rationale—What are the most frequently cited rationales for transitioning the energy economy to bioenergy and biofuels? 2} Biofeedstock Assessment—Which biofeedstocks are being proposed as biofuel inputs, and what are the pros and cons? 3} Sustainable Management of Bioenergy/Biofuels—What are the primary issues, concerns, and proposals with respect to the capacity to sustainably manage biofeedstocks cultivation, extraction, and processing? 4} Commercialization of Bioenergy/Biofuels—What are the primary challenges hindering the immediate and full commercialization of second- and/or third-generation biofuels?

them, but which also have significant material effects. The policies and regulations emerged from the discourse and they continue to play a role in shaping it. In the following paragraphs, I highlight some of the most influential policies and regulations.

With respect to biofuels, the EU Renewable Energy Directive (RED) specifies that a certain proportion of renewable energy be utilized in the transport sector, with the required proportion increasing over time (5.75% by 2010 and 10% by 2020). Initially Germany eliminated fuel excise taxes on biodiesel to stimulate its production and use. Due to Treasury revenue loss, Germany later eliminated the exemption and replaced it with quota obligations and tax rebates (Sorda, Banse, et al. 2010). Germany later passed legislation—the sustainability decree for biofuels—which encompasses regulations proposed in the RED. This decree expands the GHG emissions reduction requirement by requiring that “biofuels will have to certify that the provenience of their feedstock does not include primary forests, highly biodiverse grassland, protected territories and carbon-rich areas.” (Sorda, Banse, et al. 2010:6984).

Within the U.S., the 2010 updated version of the *Renewable Fuels Standard* (encompassed by the *Energy Independence and Security Act of 2007*) requires the transport sector to utilize 36 billion gallons of renewables by 2022. This updated version of the Renewable Fuels Standard (RFS2), differs from the original in its emphasis on the proportion of renewable fuel that must be produced from second- and third-generation (advanced) biofuels cellulosic as opposed to conventional corn ethanol. The biofuel quota specified by the original RFS did not distinguish the type of biofuel required (Schnepf, Yacobucci 2013; Sorda, Banse, et al. 2010; Stowe 2010). The material consequences of the original RFS legislation played out in the stimulation of massive production of corn ethanol. Because the production of fuel is more lucrative than food production, many farmers diverted their land from food production to fuel production. Additionally, crop-rotation practices that help retain soil vitality (e.g. rotating corn and soy) were abandoned in the rush to take advantage of economic gains.

Leading up to the passing/enactment of particular policies are the discussions and debates regarding the content and intent of the policies. Here in particular is where the line between policy and research grows fuzzy. Not only are policies formulated on the basis of research outcomes, but many biofuels practitioners serve an advisory/consulting role in policymaking. What distinguishes policies from other knowledge claims and prescriptions is the distillation

required in order to articulate knowledge claims in brief for politicians and high-level policymakers. The bandwidth for information throughput is considerably narrowed by the time the claims make it through the policy formulation stage.

As discussed in chapter one, a select group of practitioners and institutions dominate the field despite a rich variety of publications. A shared pattern of issue framing across a wide spectrum of publications and practitioners links diverse and complex issues to a common thought style. That means that a common regulatory apparatus (politics of knowledge claims) governs the way biofuels claims are produced and circulated. The circulatory scaffolding, held together by shared assumptions, also contributes to the dominance of certain practitioners and institutions.

These questions inform this part of my analysis: 1) Which publications have significant circulatory reach and what institutional platforms accord their practitioners the right to speak?; 2) Which single publications or articles are cited the most extensively, and by whom are they cited?; 3) What are the primary factors involved in continued recirculation of particular knowledge claims?; 4) For academic publications in particular, what kind of institutions are listed as providing the funding for the research and/or what institution(s) is the academic platform of the authoring practitioner(s) affiliated with?; 5) Which practitioners have significant endowments of circulation?

2.1 Circulatory Scaffolding

Table 2.1.1 (below) depicts the primary German- and U.S.-based institutions that form the circulatory scaffolding of the mainstream biofuels discourse. This scaffolding supports not only the knowledge claims issuing directly from these institutions, but also indirectly through claims circulated by practitioners located in academic institutions, environmental/energy consulting groups, NGOs, etc. Consulting groups and think tanks play a crucial role in distilling knowledge claims for consumption by non-practitioners, many of them politicians. And finally, there are the popular media sources that pick up claims, distilling and popularizing them.

The column labeled *Support and/or Partner Institutions* refers to institutes, think tanks, agencies etc. whose biofuels practitioners consult and/or conduct research for the primary

institution either formally or informally. This column also includes institutions or agencies that partner on biofuels projects with the primary institutions and agencies:

Table 2.1.1 Institutions that function as circulatory scaffolding

Germany	
<i>Government Institution</i>	<i>Support and/or Partner Institutions</i>
Umweltbundesamt (UBA) <i>(Federal Environmental Agency)</i>	Institut für Energies und Umwelt (IFEU) Öko-Institut BMU
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) <i>(Federal Ministry for Environment, Natural Conservation, and Nuclear Safety)</i>	Institut für Energie und Umwelt (IFEU) Öko-Institut UBA
Deutsche Energie-Agentur (DENA) <i>(German Energy Agency)</i>	Fachagentur Nachwachsende Rohstoffe (FNR)
U.S.A.	
<i>Government Institution</i>	<i>Support and/or Partner Institutions</i>
Environmental Protection Agency (EPA)	USDA, DOE, National Resources Defense Council (NRDC) World Resources Institute (WRI) Environmental & Energy Study Institute (EESI)
Department of Agriculture (USDA)	EPA, DOE, Federal Aviation Administration (FAA) U.S. Navy Environmental & Energy Study Institute (EESI) National Resources Defense Council (NRDC) World Resources Institute (WRI)
Department of Energy (DOE)	USDA, EPA World Resources Institute (WRI), Natural Resources Defense Council (NRDC) Ecological Society of America (ESA) Global Bioenergy Partnership (GBEP)

While my analysis also includes academic publications, I intentionally excluded universities from the foregoing table because their role in the biofuels thought collective, though pivotal, is quite diffuse and difficult to pin down to specific universities. Many academic articles

are authored by multiple practitioners from universities across the globe, although I usually selected documents for my analysis on the basis of the institutional platforms of the first two authors. In Germany and the U.S. there are university-affiliated labs that work directly with government agencies and/or receive funding from these agencies.

Although the crux of my analysis focuses on the publications from this pivotal group of institutions and/or practitioners, I cite from other publications and practitioners that are linked to this pivotal group through supporting citations and references, and via funding sources as indicated in the “acknowledgements” section of many academic journal articles. For example, emerging in a number of cases is the fact that many U.S. academic articles list the Department of Agriculture (USDA), the Department of Energy (DOE), the Environmental Protection Agency (EPA) or a combination of these agencies as their funding source or sponsor. Likewise a number of Germany-based articles cite institutions such as the Umweltbundesamt (Environmental Protection Agency) or the Institut für Energie und Umwelt (the Institute for Energy and Environment) and/or the Deutsche-Energie Agentur (German Energy Agency) as their source of funding. Even in those cases whereby articles do not reference prominent institutions as a sponsor, many cite claims produced by these agencies and/or other practitioners that were sponsored by them.

Corporations also figure prominently in the circulation of knowledge claims, often through partnering with universities on research projects. However, their influence is less obvious because there is generally no prima facie evidence of corporate backing in journal articles. Occasionally corporate backing can be located in the “acknowledgements” section of the article. Usually further inquiry into the authors and the research projects they participate in is necessary. Further diluting evidence of corporate backing are the U.S. DOE university-based national labs that frequently establish partnerships with corporations through U.S. DOE grants.

Although the frequency with which a specific publication is only part of the story, high frequencies are certainly noteworthy because they indicate the extent to which certain knowledge claims are recirculated. Particularly noteworthy are those cases in which the citing practitioners cite for the purpose of buttressing their own knowledge claims. For example, a frequently-cited publication that claims that *Miscanthus*, a grass native to regions of Asia, tends to promote biodiversity, is cited by others making similar claims.

In Appendix C I have provided four examples of the supporting apparatus referred to as circulatory scaffolding: 1) national institutional platforms (government agencies and departments); 2) international platforms (tasks forces, committees); 3) conferences, workshops, forums; 4) practitioner prestige and journal reputation:

In the following section, I lay out the various claims and prescriptions that emerged in my publication review.

2.2 Shared Set of Knowledge Claims Comprising the Mainstream Discourse

My objective in this section is to present the knowledge claims whose patterns and trends point unmistakably to a mainstream discourse. I present the claims according to the four primary themes described in chapter one. These claims can be traced back to a handful of prominent practitioners, publications, and institutions, despite their official provenance from a myriad of practitioners and platforms. This phenomenon arises through the circulation process, i.e., practitioners citing one another's claims. The citing of claims produced by practitioners with significant endowments of circulation may be considerably modified through repeated distillation. Distillation occurs as differing publication authors (biofuels practitioners or otherwise) cite the claims within the context of their own particular objectives. For example, practitioners tend to cite each other frequently, and patterns of citation emerge with the most prominent practitioners recurring in the citations of other practitioners. Adding to the recirculation of the claims are popularizing media venues (e.g. The Economist, Nature, The Wall Street Journal, Der Spiegel) where both practitioners and non-practitioners take up the claims, further distilling them for consumption by a broader audience.

I cite claims that issue directly from the institutions and practitioners I have highlighted in Appendix C (No. 4 - "Practitioner Endowments of Circulation and Journal Prestige") as well as from other sources. These other sources are linked to the primary circulation venues and practitioners implicitly through their claims and explicitly through citations. Despite the inherent heterogeneity of many of the claims they can nonetheless be characterized by a shared framework of assumptions (largely unexamined) that insure a particular commonality of production, presentation, and circulation.

In the following section, I cite from biofuels practitioners that participate in the mainstream discourse. I recognize their knowledge claims as sharing the patterns that characterize that discourse. I cite from many prominent practitioners and widely-circulated publications. At times I cite from less renowned publications and practitioners who are linked to the mainstream discourse through their citations of renowned practitioners. Additionally, I recognize patterns in the assumptions of these less-renowned practitioners that are shared in common with mainstream assumptions.

2.2.1 Bioenergy/Biofuels Rationale:

What are the most frequently cited rationales for transitioning the energy economy to bioenergy and biofuels?

The most frequently cited justifications for transitioning away from fossil fuels are to mitigate GHG emissions, to enhance energy security or energy independence, to replace a depleting non-renewable energy source, and to stimulate rural economic development (Dale, Kline, et al., 2010; Fachagentur Nachwachsende Rohstoffe 2013; Greene, 2004; Griffin, Lave, 2006; Quirin, Gärtner, et al., 2004).

Widespread concern regarding GHG emissions and their role in global warming provided a significant impetus to the rationale for biofuels, pushing them onto national energy agendas and popularizing them as a renewable energy source with significant potential. Statements such as this are echoed throughout the biofuels literature and in popular media venues: “The reduction of anthropogenic greenhouse gas emissions is one of the most important policy goals regarding climate change and global warming” (Quirin, Gärtner, et al., 2004:1)

Many practitioners single out the transport sector as a significant contributor to CO² emissions (Childs Staley, Bradley 2008; Dautzenbert, Hang 2008; Deutsche Energie-Agentur May 2, 2013; Greene 2004; Griffin, Lave 2006:21). For example, “...the EU is committed to reducing its CO² emissions, but emissions from transport are still growing [with] road transport in particular [generating] 85% of the transport sector’s emissions” (Dautzenbert, Hang 2008:285). They emphasize the urgency of finding an alternative fuel to power this sector and propose biofuels as the alternative: “Since we are

a nation [U.S.] wedded to motor vehicles, we will need an alternative to gasoline, and attention is increasingly focusing on ethanol” (Griffin, Lave 2006:21).

Other practitioners are concerned that “evidence is building that the biofuels industry is creating a host of ecological problems while failing to deliver real reductions in greenhouse gas emissions” (Earley, McKeown, 2009:3). They argue that converting biofeedstocks into liquid fuels for transport rather than using it for electricity detracts from biofuel efficiency gains because either coal or biomass must be burned to produce the heat/electricity required to convert biomass to liquid fuels. Transitioning the transport sector to an electric-vehicle fleet would be much more efficient since the electricity to power the vehicles would be generated from biomass (Early, McKeown, 2009). Still other practitioners caution that “not all biofuels are low-carbon fuels” and that the benefits in terms of reduced emissions and energy return on investment (EROI) vary depending on the feedstock used (Childs Staley, Bradley, 2008). Still others, the U.S. Dept. of Energy for instance, argue for developing advanced hydrocarbon biofuels otherwise known as “drop-in” fuels that could be utilized in the existing fleet of autos, trucks, and planes. This would make it possible to avoid the significant political and socio-economic costs of dismantling the existing infrastructure and replacing it (U.S. Dept. of Energy, July 2013).

While practitioners are not in agreement on this issue, both sides of this debate share a common framework of assumptions. Whether advocating transition to an electric auto fleet or maintaining the current structure, both perspectives are framed by the same assumption: that road and air traffic will not only continue as they are unabated, but will grow. In short, the problem is defined, not as excessive energy consumption, but rather how to meet that demand.

Concerns about energy security are often contextualized by references to rising energy demand and the potential this has to increase dependency on foreign sources of oil. For example, a publication from the U.S. DOE Bioenergy Technology Office (BETO), after appealing to the received wisdom regarding the need for energy in every facet of living, states in rather simplified terms:

Fossil fuels, such as petroleum, need to be imported from other countries. Some fossil fuels are found in the United States but not enough to meet all our energy needs. In fact, the United States is currently importing 58% of its oil from other countries. Sometimes political or social conflicts make it difficult to buy fuels from other nation. When it is hard to buy enough oil, the price can increase significantly and reduce our supply of gasoline—affecting our national security. Because

energy is extremely important to our economy, it is better to produce energy in the United State so that it will always be available when we need it (U.S Dept of Energy, Feb 2010)

Statements about the urgency of meeting growing global energy demand are frequently commingled with statements regarding the need to curtail fossil fuel dependence and safeguard national energy security (Huber, Dale, 2009; Greene, 2004; Griffin, Lave, 2006). For example, in a brief publication intended for a non-specialist audience, the Bioenergy Technologies Office of the U.S. DOE states that “rapid growth in global energy demand and uncertainties surrounding traditional oil supplies are raising concerns about U.S. energy security” (U.S. Dept of Energy, Jul 2013:3).

The transport sector figures particularly prominently in the claims that juxtapose rising energy demand with energy security vulnerabilities. In 2004, the National Resources Defense Council (NRDC) published a hefty report entitled, *Growing Energy: How Biofuels Can Help End America’s Oil Dependence* in which the authors state: “We [U.S.] import 80 percent of the oil we consume in the transportation sector, and within the transportation sector we get 97 percent of our energy from oil” (Greene, Celik, et al., 2004:1). In a later publication, also issued by the NRDC, the implications of rising energy demand on energy security are spelled out in statistical detail:

Our demand is essentially insatiable. Against this background of centrality, complexity, and challenge facing getting sustainable biomass right, it is important to realize that our demand for mobility, communications, heating, cooling – for energy services in general – is essentially insatiable. The global demand for energy is currently 516 quadrillion Btus (Quads) and expected to grow by 43% by 2035 under business as usual [...] in the USA, our current demand for oil alone is the energy equivalent of 2826 million tons of biomass, and that demand is expected to grow by 53% by 2050 if we do not aggressively implement our current vehicle efficiency and renewable fuel policies and 26% if we do not go beyond these policies to rein in our thirst for oil (Greene, 2011:12). [Academia / NRDC]

Practitioners writing for *Scientific American* target the transport sector as a primary driver of rising energy demand. They opine that since “civilization is not about to stop moving, [...] we must invent a new way to power the world’s transportation fleet” (Huber, Dale, 2009:52) [Academia/DOE], because dependence on petroleum is a national, economic, and environmental security issue. In a similar vein, the following claim treats the growth in automobiles and road traffic as inevitable, with unfortunate side effects that include exacerbated GHG emissions and increased dependence on foreign oil supplies. For example:

When the US becomes serious about addressing energy security, greenhouse gas emissions, and the sustainability of our transportation infrastructure, petroleum use will need to be cut substantially. Since we are a nation wedded to motor vehicles, we will need an alternative to

gasoline, and attention is increasingly focusing on ethanol (Griffin, Lave, 2006:9)—[Aspen / DOE]

Stimulation of rural economies is frequently raised by practitioners as a justification for transitioning to biofuels. Practitioners allude rather generally to the opportunities this new fuel economy will provide: “Another promise of biofuels—and one of the main political engines behind them—is their potential to increase farm incomes and strengthen rural economics” (WorldWatch Institute, 2006:3). Other practitioners, while acknowledging the allure of biofuels for economic development—“in most countries [biofuels] add a new income stream for rural communities”—add a cautionary note regarding the potential for large agribusinesses to appropriate land already in use by local populations (Childs Staley, Bradley 2008:3)..

Farm subsidies have been a matter of strenuous debate in the U.S. and the EU for many decades. In the U.S. in particular, directing part of the corn crop toward ethanol was a way that intervals of grain surpluses could be alleviated in order to take pressure off of the U.S. Treasury in subsidizing farmers’ losses (citations). Current discussions about stimulating rural development are often directed toward providing farmers with alternative market prospects for their produce.

Practitioners recommend co-locating biofuels processing facilities in rural areas: “Biorefineries may potentially serve as regionally self-sufficient energy facilities, independent of national transportation and power” (U.S. Dept. of Energy July 2013:1). In this case, small farmers could avoid the costs of transporting bulky biomass long distances and would thus stand a better chance of competing with large, centrally-located biorefineries.

Developing nations are cited as regions that could benefit from the growth of the biofuels/bioenergy industry: “Indeed, robust bioenergy markets and improved prices for commodities could boost incomes and opportunities in developing nations where a much higher percentage of the population lives in rural areas and depends upon the land and agriculture for incomes” (Dale, Kline, et al., 2010:10). Some suggest that farming cooperatives could own and operate biorefineries (citations), and others point to the risk to small farming communities posed by large agribusinesses:

The ability to grow energy crops in addition to food and fiber crops could transform agriculture more profoundly than any development since the green revolution [...] as biofuels become a major commodity, larger farms and agribusinesses will play a growing role. Agricultural resources are unevenly distributed in many countries, and the ability of small farmers to benefit from biofuels

will be determined in part by broader decisions about land reform and tax policies. If smaller-scale production is to be nurtured as a way of distributing the economic benefits of biofuels, government policies will be needed to encourage this (WorldWatch Institute, 2006:3-4).

2.2.2 Biofeedstock Assessment:

Which feedstocks are being proposed as bioenergy/biofuel inputs, and what are the pros and cons of each?

Research directed toward assessing which biofeedstocks will make the most suitable inputs for biofuels measures the biofeedstocks according to their GHG performance. That is, practitioners measure the amount of CO² (and in some cases nitrous oxide) emitted in the cultivation, harvesting, and processing of each type of feedstock. Practitioners emphasize that cultivation practices play a significant role in the performance of any particular feedstock (Duke, Pouyat, 2013:9; Hennenberg, Fritsche, 2009:32; Reinhardt, Rettenmaier, et al., 2007:5).

First-generation biofuels are generally produced using traditional food crops such as corn, sugarcane, rapeseed, and soy. First-generation biofuels are sometimes characterized as “low-hanging fruits” because farmers have been growing such crops for many, many years and are thus quite familiar with the different strains and the agricultural practices required in cultivating them. To date, assessments of corn ethanol indicate an abysmal record in terms of its carbon performance and other sustainability issues (Greene 2004; 2011; Marshall, Greenhalgh, 2006; Marshall, Sugg, 2010; Westcott, 2009). Practitioners often frame the carbon performance of corn ethanol within the context of the comparatively much better performance of cellulosic biofeedstocks:

Corn ethanol had been unpopular from the start in many [U.S.] states. Critics questioned the environmental, energy, and climate benefits of corn ethanol. Its production can be relatively resource intensive, requiring large amounts of land, water, and fossil fuel inputs, and it can produce significant amounts of greenhouse gases (GHG) and other environmental harm (Stowe, 2010:9).

Two studies indicating that biofuels from food-crop based sources (e.g., corn, soy) can be have more damaging emissions impacts than petroleum (Fargione, Hill et al. 2008; Searchinger, Heimlich, et al. 2008) have gained significant renown due to practitioner recirculation and ongoing debate over the findings. These studies determined that “higher prices triggered by biofuels will accelerate forest and grassland conversion [in Latin America] even if surplus croplands exist elsewhere” (Searchinger, Heimlich, et al. 2008:1240). These practitioners conclude that because the carbon uptake of each new season of fresh crops cannot make up for

the loss of mature forests and grasslands, “biofuels from converted lands have greater GHG impacts than those of the fossil fuels they displace” (Fargione, Hill et al. 2008:1236). In both cases, the practitioners conclude that the use of good cropland for biofuels leads to this problem as food production then must be diverted elsewhere and this diversion often leads to the conversion of forestland, peatlands, or grasslands.

The most frequently stated issue with respect to corn cultivation, not just for ethanol production but for food, are the intensive agricultural inputs utilized in order to obtain higher yields (Childs Staley, Bradley 2008; Duke, Pouyat, et al. 2013; Groom, Gray et al. 2008). All things considered, the energy intensity of corn cultivation is quite high, particularly when factoring in the application of chemical fertilizers and pesticides/herbicides: “producing ethanol from grain and corn, as is done in the U.S., is an energy-intensive business, typically yielding a fuel containing only 1.3 to 1.5 energy units for each energy unit used in production” (Childs Staley, Bradley 2008:2). An added factor in this energy intensity is that biorefineries burn coal for the fermentation process. Thus, although the performance of corn ethanol in its utilization in vehicles is, like sugarcane ethanol, much better than fossil fuels, the cultivation of corn coupled with the processing required to produce ethanol negate this advantage.

Beyond the problematic GHG emissions associated with corn cultivation are concerns regarding extensive soil and water quality damage as witnessed by the hypoxic (dead zone) conditions in the Gulf and Chesapeake Bay regions (Dale, 2008). “Given the correlation of nitrogen application rates to stream concentrations of total nitrogen, and the latter to the increase in hypoxia in the nation’s waterbodies, the potential for additional corn-based ethanol production to increase the extent of these hypoxic regions is considerable” (National Academy of Science 2007:31).

Some studies note that the increase in corn yields achieved through plant breeding and genetic modification have improved the LCAs of corn considerably when compared with fossil fuels (citations). One of the U.S. interviewees made this observation: *‘There are ways of using conservation biomass and biomass crops...as a way of improving the resilience sustainability of corn production while also generating the next generation of bioenergy...and so, if you’re talking about nutrients lost in surface water from row crop production, well, buffers soak that stuff up really well and you can shrink the size of that dead zone in the Gulf of Mexico if you’re better at*

promoting multifunctional agriculture.' (Interview Data NSEESI-2013). However, the consensus among practitioners is that efforts should be directed toward the utilization of more sustainable feedstocks. As a 2012 report from the USDOE states, "To date, increases in corn yield have helped to keep pace with demands, but this water- and fertilizer-intensive crop cannot continue to meet projected needs for feed and biofuels" (USDOE, 2012:6).

Corn ethanol provides a noteworthy illustration of how political instruments are shaping the fuel transition. For instance, in the U.S. the first version of the Renewable Fuels Standard (RFS) set quotas mandating that a specific portion of transport fuels consists of ethanol (Stowe 2010; Marshall 2006). Because the more sustainable second-generation biofuels were not ready for full-scale commercialization, corn ethanol became the default biofuel in the attempts to meet the quotas. Policy instruments such as this, not surprisingly, stimulated a rush on the part of farmers and ethanol producers to meet these quotas. And of course, corn ethanol cultivation and processing technologies proved to be the low-hanging fruit requiring little in the way of up-front investment risks.

Although rapeseed—cultivated in the European Union and used for biodiesel—does not seem to get as much negative 'press' as corn, there are some similar concerns with regard to the inputs required to achieve the biodiesel output. As one practitioner described it: *'the UBA [Umweltbundesamt] is skeptical of rapeseed ... it is a very inefficient plant ... it takes lots of nitrogen to get the yield. You get one-third oil and a two-thirds protein-rich cake. If you factor in byproducts, it looks better, but it's still very costly'* (Interview data / Öko)

Another consideration with these first-generation biofuels is that such "bridging" (i.e. interim) solutions usually do not work as anticipated. Considering that such bridges often perpetuate momentum leading to path dependency, a complete transition to the next generation of biofuels may be more complicated than practitioners assume. After all, the bridge solutions require socio-economic and political investments and the alliance of various interests. With time, the accretion of investments and interests will reinforce the bridge solutions, turning them into semi-permanent features of the agricultural socio-technological regime. At this stage, transitions to a next generation of biofuels become more politically and socio-economically costly.

Commonly referred to as “second-generation” biofuels, cellulosic biofuels are distinguished by the use of plant inputs (biofeedstocks) that are characterized by their cellulosic or lignocellulosic content. Extensive research has been conducted on perennial grasses in the U.S. including native varieties such as switchgrass and exotic varieties such as *Miscanthus*, a perennial grass common in certain regions of Asia (citations). Perennial trees such as poplar and willow are also being researched in U.S. and in Europe. One practitioner (interview/Germany) mentioned the extensive grasslands in Northern Germany that have followed on centuries of peat land drainage that could serve as potential second-generation biofuels. He also pointed out some of the challenges associated with cultivating poplar and willow as energy crops: *‘If you put this on agricultural land, will this be considered forestry? There are land-use planning and tax issues involved, and farmers will be reluctant to devote their land for 20 years to one crop’* (Interview Data JSUBA-2011).

Although the cellulosic ethanol product is indistinguishable from that of sugarcane or corn ethanol, the chief benefit of the cellulosic variety lies in the touted benefits of cultivation of the plants. Because they have robust rooting systems renowned for their water retention and carbon sequestration capacities, these perennial grasses do not require intensive farming practices in order to thrive:

The shift from growing annual crops to growing appropriately selected perennial crops is expected to improve soil quality. Soils benefit when no-till or low-till farming practices are employed because these practices significantly reduce soil disturbance and erosion. The roots of perennial plants tend to increase soil porosity (the capacity of soil to hold water) and the amount of water infiltration that can occur at a site. And when compared to traditional annual crops, perennial crops are likely to increase the amount of carbon the soil holds, especially in areas where the soil is of relatively poor quality (Dale, Kline, et al. 2010:7).

Practitioners expect that perennial grasses like switchgrass and *Miscanthus* will address, at least in part, concerns about land use because they can be cultivated on land that is not suitable for conventional food crops like corn and soy: “The real benefit of the grasses, however, is not in their yields but in the fact that they can be grown with relatively little energy input (including minimal inorganic fertilizer and pesticide use), with potentially positive effects on soil and water quality and wildlife habitat, and on lands where raising corn, soybeans, and other food crops would not be feasible” (Earley, Mckeown, 2009:7). Life-cycle assessments (LCAs) for ethanol derived from cellulosic sources reveal considerably lower carbon emissions than corn ethanol because the application of fertilizers, herbicides, and pesticides contributes to GHG emissions

(citations). Interestingly, growing switchgrass without fertilization significantly decreases soil carbon and nitrogen and therefore does require some fertilization (Duke, Pouyat, et al. 2013). As this practitioner (interview / U.S.) stated: *‘If you grow switchgrass, you’re taking away nitrogen and carbon from the soil and if you don’t replace it then you’re going to lose it and where Miscanthus we think fixes its own nitrogen or generates its own’* (Interview Data WPESA-2014).

Another cellulosic alternative undergoing research is corn stover which falls under the general designation “agricultural residue”—the stalks left in the field after the corn has been harvested. Farmers usually leave the corn stover in place after harvesting the fruit because it performs a valuable service in replenishing the soil with nutrients after the corn has been harvested. It also plays a role in preventing topsoil erosion. Research on the use of agricultural residue includes conducting an impact assessment to determine how much residue can be removed without harming the soil (Blanco-Canqui, 2009; Marshall, et al. 2009).

One of the attractions of utilizing corn stover as a bioenergy feedstock is that it will not compete with food for the land since the corn fruit will already have been harvested. But as some practitioners warn, market demand may create incentives for farmers to extract the corn stover prematurely. “Scaling up corn stover harvest may result in unacceptable losses of productive topsoil to erosion, declines in surface water quality due to increased sedimentation and eutrophication, and loss of agricultural carbon sequestration capacity and associated increases in GHG emissions from agricultural activities” (Marshall, et al. 2009).

Another bioenergy feedstock promoted by practitioners is cow manure because like stover, it will not compete with food, and unlike stover, it does not require significant hectares of land for cultivation. Some practitioners indicate that the value-added of utilizing cow manure as a bioenergy feedstock will contribute to economic development of the rural economy (citations). Farmers will be in a position to sell the manure along with their crops, thereby increasing their incomes.

Biofuels provides an entirely new use for forest biomass—dead wood, branches, etc.—that has traditionally been extracted as part of a forest-fire prevention regime. Biomass such as dead wood and branches serve a purpose in restoring nutrients to the soil. Practitioners point out that increasing demands for biomass removal means that extra vigilance must be exercised to

insure that excessive removal does not harm the health of forests (Dale, Kline et al. 2010; Fritsche, Hennenberg, et al. 2012; Glaser, Glick 2012).

Perennial feedstocks such as switchgrass, *Miscanthus*, and certain types of trees such as poplar and willow are hailed for their potential as biofeedstocks because their energy yield is quite high compared to rapeseed, soy, corn, or even sugarcane. And as these practitioners point out, yield is a function of the landscape and climate of the region in which the plants are cultivated:

U.S. test plots planted with switchgrass have yielded enough biomass to produce nearly 1,200 gallons of ethanol per acre annually, using fewer energy inputs than corn. (In contracts, a bumper crop of 180 bushels of corn per acre will provide less than 500 gallons of fuel.) In practice, however it makes sense to grow switchgrass and other perennial biofuel crops on more marginal lands than in the test plots, and in drier and colder climates, to avoid competition for good farmland. Under these conditions, the grasses will produce less than 500 gallons, unless yields are improved with breeding (Earley, McKeown, 2010:7).

Yet while yields may decrease in these less fertile areas, the point is often made that the robust root structure of these perennial species makes them especially well-suited to grow in regions of the globe where cultivating traditional food crops is not feasible (citations). Still, some practitioners recommend exercising caution because full commercialization of perennial plants grown on marginal or abandoned lands will require additional agricultural inputs to increase their yields. Utilizing a model to forecast the impact of increasing yields through additional applications of agricultural inputs, these practitioners found that switchgrass cultivation could actually contribute to GHG emissions:

...this analysis highlights the possibility of significant increases in agricultural GHG emissions arising from increased total nitrogen fertilizer use for switchgrass production. Commercial switchgrass production methods for the purposes of bioenergy production are still highly uncertain, and it is critical to understand the types of tradeoffs that may exist when fertilizer use is intensified to increase yield. Research on bioenergy crop yields should explicitly consider the sustainability implications of new varieties and production methods along multiple dimensions in order to ensure that unacceptable tradeoffs are not being exacerbated and embedded in yield-oriented production research (Marshall, Sugg, 2010:11).

Practitioners conducting life-cycle analyses to determine the CO² emissions performance of various biofeedstocks propose that co-products of biofuels production be credited to the final emissions figure because these products would need to be produced elsewhere utilizing inputs and processes that result in GHG emissions:

CO² is produced [...] in the production of nitrogen-containing fertilizers or from the diesel used in agriculture machines. On the other hand, in the production of biofuels co-products are generated,

which substitute conventionally manufactured products and the necessary non-renewable primary energy used in their production [...] Conventionally produced products are substituted by the co-products arising from biofuels production. Biofuels credits comprise the non-renewable primary energy needed for the manufacturing of the conventional products and the greenhouse gases set free in such production (Quirin, Gärtner, et al., 2004:12, 5)

Practitioners also propose that the utilization of biomass for the co-generation of heat and electricity also be factored into the life-cycle assessments (citations).

Advanced biofuels (often referred to as third-generation biofuels) are the focus of much of the ongoing research into sustainable biofeedstocks. The aim with this generation of biofuels is to locate and/or develop feedstocks that combine high yields with significantly less requirements for land/soil. It may also come as a surprise to some, as it did to me, that the USDOE has been conducting research on algae as a potential biofuel for at least the past few decades. “Algae production has great promise because algae generate higher energy yields and require much less space to grow than conventional feedstocks. Algae also would not compete with food uses and could be grown with minimal inputs using a variety of methods” (Earley, McKeown, 2009:7). Other practitioners are a bit more guarded in their prognoses regarding algae mainly because, despite the research conducted to date, there is still much technological experimentation and development that must take place before algae as a biofeedstock can become a reality:

Algae as possible no-iLUC feedstocks for biofuels became an issue in the last years, with high expectations especially for land-based micro-algae due to assumed very high yields, and their insensitivity to productive land. Still, there is little evidence today that algae-based biofuels are near-term options, and their overall economic and environmental performance is questionable unless significant progress—by a factor of 10 or more—is made (Fritsche, Hennenberg, 2010:28).

Another form of advanced biofuel is syngas, which is a synthetic gas produced using biomass and belongs to the group of fuels known as “drop-in” fuels because syngas can be utilized by existing engine, distribution, and storage infrastructures. That is, while fuel that contains more than 10% ethanol requires modifications to existing combustion engines and cannot utilize the same pipelines and storage tanks utilized for oil and gas, drop-in fuels, can be utilized with the existing infrastructure (citations). The Federal Aviation Administration (FAA) in conjunction with airline industries and the USDA are promoting the development and use of drop-in fuels for aircraft, since modifying jet engines to accommodate ethanol is cost- and time-prohibitive (citations).

I have picked up on a trend in the more recent literature regarding the use of solid municipal waste and the capture of methane from landfills. These offer better prospects even than algae as no cultivation is necessary and they provide the additional advantages of mitigating the amount of methane—a GHG many, many times more potent than CO²—escaping into the atmosphere while also alleviating the need to allocate so much land to landfills.

Municipal solid waste (MSW) and construction and demolition debris (CDD) diverted from landfills avoids generation of methane gases that would otherwise occur in a landfill. In the State of Maine, diverting post-recycled or non-reusable portions of waste has resulted in an 85-90% reduction in landfilling needs, helping to extend the lifetime capacity of the landfill (Perla, 2010:227).

2.2.3 Sustainable Management of Bioenergy/Biofuels:

What are the primary issues, concerns and proposals with respect to the capacity to sustainably manage biofeedstock cultivation, extraction, and processing?

Much of the research conducted on biofuels involves assessments of the agricultural and forestry practices involved in growing and extracting energy crops and the impact these will have on land, soil, water, and food production. The potential for massive land-use change (LUC) stimulated by the cultivation of energy crops on a global scale has raised concern amongst practitioners. Thus, many practitioners are involved in developing reliable tools and methods to assess LUC and sustainable cultivation practices (citations).

The need to insure the sustainability of the cultivation and extraction of particular biofeedstocks is frequently raised:

Considering the risk of palm oil production for nature and environment and a continuous demand for this energy source, the actual benefits of palm oil utilization as a contribution to the reduction of greenhouse gases has to be assessed. In particular the extension of cultivated areas should accompany a stringent use of tropical fallows. The efficient applications of this option and the assessment of the cost-effectiveness require urgent research (Reinhardt, Rettenmaier, et al., 2007:5)

Cultivation of energy crops involves both direct and indirect land-use change (iLUC). Direct LUC occurs when the cultivation of energy crops directly replaces an alternate use of the land. For example, cultivation of crops for food in a particular region gets replaced by energy-crop cultivation, or land devoted to cattle ranching is now appropriated for sugarcane cultivation, or a forest is razed to make way for a palm oil plantation. Indirect land-use change (iLUC) occurs when the appropriation of land for energy-crop cultivation in one area or region results in displacement of the previous use of the land to another region. For example, Brazilian sugarcane

cultivation which does not thrive on freshly deforested land often directly replaces cattle ranching (i.e. direct LUC). The displaced cattle ranching is then taken up in the rainforest region, thereby stimulating deforestation (Childs Staley, Bradley 2008).

The displacement of sheep or cattle grazing from one region of the globe to another due to allocation of land to energy-crop cultivation is far more than simply a matter of moving an activity from one place to another. Every region has a unique set of variables and life forms which the displaced activity will interact with, and there is no telling what changes this may bring into effect and how far-reaching the consequences. Therefore, landscape ecologists among others view land-use displacement as an issue requiring more attention and research (Finkbeiner 2013; Liska 2009).

Practitioners readily acknowledge the complexities associated with assessing land-use change, indirect LUC in particular. The challenge associated with assessing indirect LUC lies in the difficulty of linking the appropriation of land for energy-crop cultivation in one region with the region to which the former use of the land gets displaced (Duke, Pouyat 2013; Fargione, Hill et al. 2008; Finkbeiner 2013; Fritsche, Hennenberg 2012; Searchinger, Heimlich, et al. 2008; Stowe 2010). Referring to the previous cattle-ranch example, how can practitioners ascertain that the rainforest razed to make way for cattle ranching resulted from sugarcane cultivation in another region? And even if they may be able to establish a general link between the two activities, they will still be at pains to determine precisely which region of energy-crop cultivation actually resulted in the displacement.

Debate about the best way to assess these changes remains open and unresolved, with some practitioners proposing modeling schemes that can provide approximations based on current uses and assumptions about the future (Dale, Kline et al. 2011; Fritsche, Sims et al. 2010). Direct LUC, though somewhat more concrete still presents challenges because of the difficulty in determining a baseline for measurement (citations), e.g., do/can practitioners know how the land was used previously and how far back should they go, and how do they account for the fact that not all locales or regions are equal? In sum, since land is impacted by a complexity of anthropogenic interventions coupled with regional geographic and climate variations, a baseline for LUC is difficult if not impossible to establish.

Yet another factor complicating LUC assessment is that the majority of assessments conducted analyze only carbon emissions. Yet, as some practitioners point out, use of land involves much more than carbon emissions; it impacts water quantity and quality, soil erosion, soil organic carbon, nitrogen and phosphorous leaching, among other things (Dale 2008; National Academy of Science 2007). Indeed, the expanding “dead zones” in the Gulf and Chesapeake Bay regions are attributed to intensive industrial agricultural practices that generate significant runoff of nitrogen and phosphorous. And of course, carbon is not the only greenhouse gas (GHG) emitted through land-use change. U.S. industrial agricultural practices utilized in corn cultivation result in carbon and nitrous oxide emissions; the carbon emissions resulting from a combination of fertilizer production and tillage practices and the nitrous oxide resulting from the nitrogen leaching once the fertilizer is applied.

While the concern about the impacts of corn cultivation may seem less proximate to Germany-based practitioners, the cultivation of corn, soy, rapeseed, palm, and other cash crops is on the rise in many regions of the globe, thus raising the concerns of biofuels practitioners across the globe. When asked about the impacts of rapeseed cultivation (utilized extensively as an input for biodiesel), Germany-based practitioners informed me that EU farmers are accountable for following strict crop rotation/cultivation practices that enable soil restoration and recovery. For example, acreage devoted to rapeseed cultivation must be allowed to stand free of rapeseed cultivation for four-year intervals (Germany interview data). Even so, practitioners increasingly share similar concerns regarding reliance on traditional cash crops for fuel production because they displace food-production, often leading to the conversion of peatlands, grasslands, and/or forests to agriculture (Fargione, Hill, et al. 2008; Fehrenbach, Giegrich, et al. 2008; Searchinger, Heimlich, et al. 2008; Stowe 2010; Wiegmann, Hennenberg, et al. 2008).

One thing is certain. The LUC issue is extremely complex, particularly due to existing land uses that are in themselves becoming problematic. Most practitioners recognize the energy crop cultivation cannot be considered in a vacuum. As this Germany-based practitioner expressed: *‘Our population is moving to the most fertile land and converting it to homes, golf courses, parking lots, repacking stations for trucks... We must address this, biofuels or not... We need a global agreement on land’* (Interview / Öko). Another Germany-based practitioner alluded to other factors competing for the land: *‘I would not make a big differentiation between food and energy-crop production. We have a policy of twenty percent organic farming; we don’t*

meet this. We have a law that ten percent of the area of Germany be set aside for nature conservation; these days it's only five percent. The nature conservation areas must come from forest and agriculture areas. This means less area for commercial use in order to meet this law. To increase land devoted to biofuel crops is ridiculous because it lowers the possibility meet these other goals and laws' (Interview / IFEU).

As mentioned previously, the life-cycle analysis (LCA) is a methodological tool utilized for measuring how various biofeedstocks perform in terms of their environmental impacts, particularly with respect to GHG emissions. Often the results of these assessments are symptomatic of impacts on the land. For example, deforestation to make way for energy crop cultivation results in GHG emissions, loss of biodiversity, etc. Intensive agricultural practices that cause the release of GHGs through fertilizer application also substantially impact soil, water and the overall condition of the land. Although intended to measure all environmental impacts from cultivation all the way through fuel use (sometime called 'cradle-to-grave' or 'well-to-wheel'), most of the assessments measure GHG emissions:

The LCA incorporates data on many aspects of the life cycle, including fertilizer use, changes in crops or acreage, and energy used for growing and transporting feedstocks and for processing the biofuel. These data are then used in economic and environmental models to assess net effects on GHG generation (Duke, Pouyat, et al., 2013:7)

Some debate has ensued regarding the EPA's Tailoring Rule EPI that proposes treating the emissions from fossil fuels and from biomass as equivalent. This ruling is supported by practitioners (DeCicco, 2012) who argue that because LCA is linked to the fuel, it does not appropriately consider carbon stocks impacted by various types of land use in different regions. The carbon 'credits' issued to biogenic sources are based on assumptions that vastly oversimplify the global carbon cycle. As such, these practitioners advocate the direct measurement of emissions from fuel use for both biogenic and fossil sources and that emissions should also be directly measured at the point of production (DeCicco 2012; Finkbeiner 2013; Quirin, Gärtner 2004). Other practitioners point out that the LCA is limited because it measures emissions only and does not look at the other impacts of biofuels cultivation and processing such as: impacts on water quality/quantity, soil erosion, soil organic carbon (SOC) content (Reinhardt, Rettenmaier 2007).

Often an issue associated with the land-use change issue, impacts of particular feedstocks and cultivation/extraction processes relating to biodiversity loss, degradation of water and soil

organic carbon (SOC) content and water quality/quantity are raised. Usually such discussions occur within the context of comparing the benefits of one biofeedstock, e.g. switchgrass of *Miscanthus*, to another, e.g. corn or rapeseed. A primary motivator for employing perennial grasses as feedstocks is their capacity to foster biodiversity. Indeed, if the appropriate harvesting regime is adhered to, perennial grass patches will prove favorable to a number of bird species:

A native prairie grass, switchgrass provides abundant wildlife habitat. In particular, studies have looked at bird use of different crops. Typically, switchgrass is currently usually harvested only once a year, late in the fall, to allow for most of the moisture and nutrients to leave the harvested portion of the plant, and this timing has the added advantage of allowing most nesting species to have migrated from the fields. To maximize the protein values of switchgrass, it would be harvested twice a year, in early summer and late fall. However, the first harvest would happen after most species have hatched their young (Greene, 2004:30).

Amidst concerns about the implications of extracting corn stover from the fields after corn harvest in order to utilize the stover as a biofeedstock, proper planning and management of agriculture practices are cited as the best way to allay these concerns (Blanco-Canqui 2009; Marshall 2009). The same applies to the removal of forest residue. In both of these cases, the residue performs an enriching and restorative role with respect to the soil. Concerns center on extraction for biofuels inputs that may take place too quickly and/or in quantities that impact the soil:

Crop residues, such as wheat straw and corn stover, can also provide potential low-cost and lower-impact energy feedstocks. As they are co-produced with other crops they ‘share’ responsibility for inputs used and impacts generated. But removing crop residues can have significant environmental effects, including changes in soil carbon, increased run-off and soil erosion, and increased fertilizer applications to replace (Marshall, Weinberg, et al., 2011:44).

Cultivation, harvesting, and extraction processes in both agriculture and forestry play a key role in the long-term sustainability of bioenergy/biofuels. Practices such as crop rotation have a considerable impact on maintaining the resilience of the soil in terms of soil organic carbon (SOC) content, soil nutrient restoration, and the prevention of erosion. For example, the recommended practice for corn cultivation includes bi-yearly rotation with soybeans because soybeans have a natural nitrogen-fixing capacity which restores nitrogen to the soil, thereby making it possible to cut back on the application of industrial fertilizers (Duke, Poutat 2013; Early, McKeown 2008; Fletcher, Robertson 2011; Fritsche, Hennenberg, et al. 2008; 2012). European Community agricultural policy mandates the cultivation of rapeseed may be repeated only at four-year intervals.

Discussions centering on cellulosic biofuels and land use include recommendations to utilize marginal land—land not well-suited for agriculture—for growing perennial grasses such as switchgrass or miscanthus. As mentioned previously, one of the chief benefits of these grasses is their capacity to grow in arid regions where consistent and ample supplies of water are not available (Duke, Pouyat 2013; Early, McKeown 2009; Fletcher, Robertson 2011). They have a deep root structure that facilitates water storage and the sequestration of carbon. It is believed that growing grasses on marginal lands will mitigate the competition for cultivable land. Despite the promoting the use of abandoned or marginal lands, practitioners agree that the definition of “marginal land” varies by regional and socio-cultural context:

What “marginal” land is depends on context. The Definition of “marginal land” varies widely by country, local conditions, and the organizations studying the issue. It is a relative term; the same qualities used to classify a site as being “marginal” in one place or for one purpose can result in land being considered productive in another place or for a different purpose. Therefore, there are great uncertainties among the wide-ranging estimates of availability and suitability of “marginal land” for bioenergy crops. (Dale, Kline, et al., 2010:5)

Practitioners also claim that the robust root structure of these grasses will enhance carbon sequestration and soil nutrients. Some are working toward enhancing the grasses through cross-breeding and genetic modification to improve their capacity to grow in unfavorable locales. In some cases they propose that the advances in plant genetics make it possible to adapt particular plant organisms to extremes in climate by manipulating the “photoperiod” of the plant organism such that photosynthesis occurs earlier/later depending on the characteristics of the climate where the plants will be cultivated (citations). Similar proposals and research are in process with respect to woody biomass such as willow trees. The idea, as with the grasses, is to use plant breeding and/or genetic modification to produce trees that can be successfully cultivated in regions with harsh climate conditions (citations).

Co-products and/or byproducts of biofuels production are promoted as a means of sparing land that would otherwise need to be utilized to produce the product, e.g., livestock fodder. It is anticipated that the per-acre value of farmland will increase once the process for co-producing animal feed with biofuels is developed (Dale 2010). The leaf protein of cellulosic biomass can be obtained at the frontend of the biofuels conversion process and utilized to produce livestock feed. This protein contains the amino acids required by livestock and that is currently supplied by animal feed produced from soybeans. Not only will the value of the biomass increase because more use can be derived from it, but farmers who cultivate soybean to produce cattle

fodder will instead be able to transition the soybean acreage to biomass and obtain more value per acre from the biomass (Greene, 2004; Griffin, Lave, 2006).

2.2.4 Commercialization of Bioenergy/Biofuels:

What are the primary challenges to full commercialization of second-generation (e.g. cellulosic, residue, municipal waste) biofuels?

By far one of the most frequently cited challenges with regard to fully implementing and commercializing cellulosic biofuels is the price that must be borne by the consumer at the filling station (Coyle 2010). And of course, making the fuel available (and desirable) to the everyday customer is directly related to corporate confidence in the capacity to produce biofuels profitably. Making biofuels competitive with fossil fuels is considered a major challenge, if not in some cases an outright hurdle, to full commercialization. Although corn and sugarcane ethanol are comparable in price to liquid gas, biofuels produced from cellulosic feedstocks present some technological and distributional challenges that translate into higher operational costs and hence, higher costs at the pump and/or the electricity grid. One of the most significant technical challenges involves the process of converting cellulose into starch:

Cellulose is an insoluble substrate. It is very resistant to breakdown. The major challenge is to effectively produce the sugars needed to make the ethanolic fuels [...] We are trying to overcome one of the big economic issues in cellulosic ethanol production: making it even more cost competitive than corn-based ethanol (Saylor 2008:10).

Although biochemical and thermochemical processes have proven to be effective ways to break down the cellulose, the process is still quite costly. Plant geneticists are researching the possibility of genetically-engineered plants in which the lignocellulose will be less resistance (find articles / Bill Parton interview). As these practitioners describe it:

Nature designed cellulose to give structure to a plant. The material is made out of rigid scaffolds of interlocking molecules that provide support for vertical growth and stubbornly resist biological breakdown. To release the energy inside it, scientists must first untangle the molecular knot that evolution has created” (Huber, Dale, 2009:55).

Most recently the U.S. Department of Energy is funding research in synthetic biology to design microbes that will be capable of breaking down the rather tenacious and resistant lignocellulose, a material found in cellulosic plants and trees (U.S. Dept. of Energy, July 2013). Again, while the technology is being developed, the issue comes down to cost. As this practitioner (interview / U.S.) put it, *‘It does seem that the economics of the processing is a*

problem. It's got to be economically viable as an alternative. They know how to do it but can you do it economically' (Interview Data, WPESA-2014).

Another cost associated with cellulosic biofuels involves the transport of the biomass. Due to the bulk of the biomass, these feedstocks require more transport resources than conventional grain feedstocks. Some practitioners are looking at processes to break down the feedstocks into pellets for easier, less costly transport (Fachagentur Nachwachsende Rohstoffe 2009).

The trend of many agency publications is to suggest or imply that cellulosic biofuels will be ready for full commercialization in the near-term (U.S. Dept. of Energy 2012; 2013; Fachagentur Nachwachsende Rohstoffe 2009), although there some practitioners who claim otherwise (Greene 2004; Saylor 2008; Stowe 2010; Westcott 2009). When I posed the question of the readiness of cellulosic biofuels for commercialization to some of my practitioner interviewees, they indicated that often the reports of imminent readiness are exaggerated. Indeed, while there are competing claims regarding the readiness of cellulosic fuels for commercialization, all practitioners tend to agree on the fact that the economic factors are among the most challenging hurdles. The technical challenges actually translate into economic ones because complex conversion processes are more costly. Complicating all of this is the price volatility of oil. "The price of oil through the 1980s and much of the 1990s was far below what many had forecast, and that dramatically reduced incentives to invest in cellulosic technology" (Berton, Kovarik, et al., 2010:xxiv).

As in the publications, they point out technical and economic hurdles still to be overcome. First-generation feedstocks are the cheapest overall because they allow the use of familiar cultivation practices and available technologies. Additionally, the composition of feedstocks such as corn and sugarcane makes the process of obtaining the sugars much simpler; there are no recalcitrant elements such as cellulose or lignocellulose. By far the cheapest feedstock to process is sugarcane because the sugar is obtainable without the preliminary breakdown of starch required in the case of corn.

There exists a fairly broad consensus among practitioners that government intervention in the form of policy instruments and financial investment is necessary to insure that biofuels become competitive with petroleum and ultimately replace it as a primary fuel source (citations).

Much of biofuels development is being initiated by the private sector in conjunction with academic institutions, often through funding provided by government agencies. Of course the pattern of corporate-academic partnership and distribution of government funding varies by nation and by regions within a nation, but it nonetheless leads to a similar observation among practitioners regarding the need for some form of government-sponsored initiatives to insure a successful transition to biofuels.

Practitioners express concern that, in face of the costs of converting advanced biofuels, many private firms are reluctant to invest. “Capital investment costs for cellulosic ethanol plants are estimated at three to four times those for first-generation biofuel plants” (Coyle 2010). Potential investors, while they see the promise of second- and third-generation biofuels, are concerned that production costs will prevent these fuels from being competitive with other sources such as fossil fuels and corn and sugarcane ethanol, and rapeseed biodiesel.

In sum, proponents of such initiatives believe that government must play a significant role in “creating” a market for bioenergy/biofuels, otherwise the de facto fuel choice will continue to be fossil fuels. One U.S. practitioner expressed the difficulties involved in leaving things to ‘the free market’ because presently ‘*the oil industry has no free market but it is the market*’ (Interview Data, NSEESI-2013). Indeed, many practitioners, at the behest of corporate concerns, advocate Keynesian-style economics, with government stimulating private investment through significant investment in corporate research, prototype testing, and commercial implementation. A frequently expressed concern is that biorefineries for cellulosic fuels are very costly compared to plants required for processing corn ethanol. In order for private corporations to be willing to make these longterm capital investments, they need to receive some assurance that such investments will pay off over the long haul (Caputo 2009; Coyle 2007; 2010; Sandalow 2006; Worldwatch Institute 2006).

Another technical challenge to transitioning to cellulosic biofeedstocks involves the transport of the feedstocks to the biorefineries and the transport of the fuel from the biorefineries to the various fueling stations. According to Westcott (2009), “the need to develop supporting infrastructures at every step along the way from the field to the pump will further hinder rapid large-scale growth” (p.30). To defray the additional costs of transport associated with the inherent bulk of cellulosic feedstocks, some recommend locating biorefineries in regions where

the energy crops are cultivated. Because existing gas/oil pipelines cannot be utilized due to the hydrophilic and corrosive nature of ethanol, biofuels must be transported by truck and/or train to fueling stations (Childs, 2008). As one Germany-based interviewee described it, ‘*The oil industry says they cannot send the ethanol through the pipelines due to the risk posed by ethanol to pipe corrosion*’ (Interview Data, JSVDA-2011).

2.3 The Persuasive Power of Rhetorical Juxtaposition

Publication titles and images can be particularly effective distillations of the discourse. Many titles are designed to be catchy in order to peak reader interest by appealing to the popular imagination. Many agency and think tank publications designed to appeal to a non-practitioner or non-expert audience are carefully designed with the clever juxtaposition of catchy phrases, titles, and powerful imagery intended to convince. The following two figures (2.3.1.1 & 2.3.1.2) consist of illustrations, one each taken from a Germany-based agency—*Fachagentur Nachwachsende Rohstoffe* (Agency for Renewable Resources) and the U.S.-based publication, *Scientific American*. Both of these publications were designed to appeal to a non-practitioner (i.e. non-specialist) audience, e.g., politicians and concerned or interested citizens. The illustrations are particularly noteworthy for their use of rhetorical juxtaposition of imagery and text to convince and persuade. Perhaps most noteworthy about these distillations is that they tend to appeal to people at an emotional level through the use of commonly-understood metaphorical imagery and text.

Figure 2.3.1.1 Rhetorical Juxtaposition of Images and Text (Germany-based practitioners)

Note the clever juxtaposition of opposing views (the critics vs. the proponents) to get the point across. On the lefthand side, the introductory phrase, “Auf den ersten Blick” (At first glance) introduces a common criticism of biofuels: “Äcker für Energiepflanzen zerstören Wiesen und Widen” (Energy crop cultivation destroys meadows and pastures). Juxtaposed with the text is an image depicting a field nearly completely plowed under by a tractor tilling the soil for energy-crop planting. The righthand side suggests that the criticism is unfounded with a definitive statement—“Dem Grünlandumbruch sind strenge Grenzen gesetzt (There are strict limitations to the excessive fragmentation of grasslands.)—meant to instill confidence in the capacity of government policy to insure sustainable agricultural practices are followed. Take note of the image portraying the limitation through the use of commonly-understood symbols.



Source: “in Sachen Energiepflanzen”, 2010
Used with permission of Fachagentur Nachwachsende Rohstoffe e.V., 2015

Figure 2.3.1.2 Rhetorical Juxtaposition of Images and Text (U.S.-based practitioners)

The cover of this issue (lefthand side) arouses curiosity through the juxtaposition of an intriguing image—the outline of a gas pump mown from a large field—and the term “Grassoline”, a catchphrase formed by an elision of the words “grass” and “gasoline”. This juxtaposition frames the key argument of the article—“New fuels made from weeds and waste could halve U.S. oil needs”—making it powerfully persuasive, particularly to non-specialists.

The image on the righthand side was taken from an inset in the article. Note here the juxtaposition of the cattle with a catchy title consisting of a play on words—“The Fat of the Matter—that hints at the main premise of the accompanying writeup—the use of cattle, pig, and chicken fat to produce biodiesel.



Source: Scientific American, July 2009 Issue
 Used with permission of Nature Publishing Group, 2015

2.4 Concluding Reflections

In this chapter, I described a set of knowledge claims, hinting at the commonalities that shape their convergence into a single mainstream discourse. Implicit norms regulate the production and circulation of these claims by insuring that all practitioners adhere to the same set of practices. Assumptions play a fundamental role in the foregrounding and backgrounding that informs the construction of maps of reality by practitioners. In the subsequent three chapters, I expose the frameworks and assumptions that give the discourse its particular character as a mainstream or dominant discourse. The value added by this exposure lies in gaining insights into the regulation of the discourse (i.e. the politics of knowledge claims).

While evidence exists of rich diversity and debate amongst biofuels practitioners, a lot hangs on how an issue is framed since the framework of unexamined assumptions is what links various claims together. For example, irrespective of the potential for negative, irreversible outcomes of a proposed technology, process, or practice, an unexamined faith in human scientific and technological capacity to devise the means for sustainably managing complex ecosystems generally frames the discussion. Another noteworthy example: some practitioners (Dale, Kline, et al., 2010) recognize that injustices could result from designating land as “marginal” or “degraded”. However, they tend to proceed on the assumption that these issues can and will be worked out by some group or other of experts. To summarize my point, it is not that mainstream practitioners deny the issues and/or refuse to acknowledge them. Rather, the problem stems from unexamined frameworks that hinder certain perspectives from receiving a proper hearing.

Emerging in the knowledge claims and their framing is a discussion of issues that takes place within a restricted zone. The perimeter of this zone is defined by a cultural narrative that views progress as a linear trajectory inextricably linked with economic growth. Discussions centered on increasing yields and/or improving fuel economy for automobiles all have as their basis the premise that economic growth is inevitable and will continue unabated. Practitioners, rather than interrogating the rising energy demand they frequently allude to, treat it as an inevitability that is beyond human capacity to alter. In sum, the knowledge claims circulated by the mainstream discourse define problems and propose solutions based on the premise that the

effectiveness of biofuels/bioenergy will be measured by their capacity to facilitate economic growth, while mitigating the climate and ecological impacts of this growth.

The framing or presentation of the issues by unexamined assumptions can take away from otherwise well-thought-out analyses of the situation. Many of the practitioners cited in the previous section demonstrate a clear understanding of the environmental and ecological implications of following a particular trajectory too quickly without adequate deliberation of the consequences. Naturalized givens tightly interwoven into the fabric of the larger society recede into the background, making it impossible to see them as part of the problem unless somebody exposes them. Yet interrogating these givens in some contexts can mean risking one's professional career. Importantly, the idea that societal progress is synonymous with economic growth frames the mainstream biofuels discourse as it does broader energy discourse. Rising energy demand, associated with economic growth, assumes the status of an unquestioned independent variable that determines all other variables. It therefore never enters into the problem definition.

The discourse is also framed by the assumption that innovations in science and technology can adequately address complex socioeconomic and ecological issues. Despite evidence demonstrating otherwise, there seems to be an overriding faith in the idea that the permeation of society by scientific and technological innovations will automatically bring about improved social health and welfare.

In the ensuing three chapters, I address these and other assumptions in further detail as I launch into ground truthing the discourse in order to understand and describe its material consequences.

Chapter 3: Ground Truthing I - The “Standing Reserves” of Biofuels Deployment

*“What we observe is not Nature itself but
Nature exposed to our method of questioning”*

--Werner Heisenberg¹³

*“Our attitude toward plants is a singularly narrow one.
If we see any immediate utility in a plant we foster it.
If for any reason we find its presence undesirable or a matter
of indifference, we may condemn it to destruction forth with.”*

--Rachel Carson¹⁴

Here I commence the ground-truthing analysis, continued in chapters four and five, in which I critique the potential material effects of the discourse. As stated in chapter one, ground-truthing involves assessing the maps constructed by biofuels practitioners. The critique that follows highlights the potential impacts of the discourse on agricultural practices, ecosystems, and socio-economic conditions. Ground-truthing demonstrates the *performative* potential inherent within the discourse. I discuss the plants and organisms intended as raw material for biofuels processing, describing how the maps representing them can lead to their assimilation into the energy enterprise. The discourse *performs* through this domestication and assimilation of plants into human projects. Additionally, I critique the unexamined frameworks (or assumptions) of the thought collective since these play a critical role in shaping construction of the maps. By describing what the maps privilege and what they marginalize, I shed light on these implicit assumptions.

The phrase “standing reserves” in the chapter title refers to the challenging forth (*herausfordern*) of life forms such as plants and trees as objects to be taken up into the human enterprise (Heidegger 1977; Rojcewicz 2006). Thus, switchgrass is “challenged forth” by the biofuels practitioners as “standing reserve,” waiting and ready for deployment to human projects. Organisms disclose themselves according to the questions put to them by their human observers,

¹³ Cited in, Gleiser, Marcelo (2014). *The Island of Knowledge: The Limits of Science and the Search for Meaning*, New York: Basic Books, p. xiii

¹⁴ Carson, Rachel (1962). *Silent Spring*

a phenomenon referred to as the “essence of technology” (Heidegger 1977). Life forms—plants, soil, microbes, water—disclose their being according to the method of questioning utilized by practitioners. Scientific questioning, never open-ended, “is a questioning set up in advance, ordered to a particular answer” (Babich 1999). The essence of technology involves an “enframing” (*Ge-stell*) which impedes the bringing forth or disclosing of being on the part of an organism. “The technological imperative of the *Ge-stell* [...] reduces everything to mere resources on call [i.e. “standing reserves”], for sustainable management or heedless exhaustion according to the whims of market and political sensibility as stock and reserve” (Babich 1999).

The language we use to describe the nonhuman—“natural resources”, “natural capital”, “agricultural residue”, “ecological services”, “livestock”—exemplifies this technological enframing (*Ge-stell*). The instrumental gaze involves an ordered set of questions according to which organisms disclose themselves. For example, water is viewed as a “precious resource” with the discussions about threatened “water supplies” narrowly focused on its use-value. Because technological solutions do not account for water as a *living system* in its own right, they may exacerbate the situation in the long run. In sum, scientific questioning renders impossible what phenomenologists deem as an attentive, open-ended ‘*presence-ing*’ that facilitates the disclosure of being on the part of the organism.

This idea of “standing reserves” is particularly pertinent to practitioners’ search for the ideal raw material as a biofuel input. All of the life forms I address herein play a role in biofuels cultivation and production. The plants selected by the practitioners have features that make them especially suitable as biofuels inputs. The questions put to these plants by the practitioners are ordered toward a particular response, e.g., what is the most efficient means for obtaining high yields? Assimilation and domestication of the plants occur through the application of agricultural and genetic practices geared toward capitalizing plant attributes that can increase yields.

In the first section I explore how the maps of the thought collective can serve as speech acts, making certain realities materialize. I discuss the potential for the practices implicated by the energy-crop map to bring about monocultures aimed at attaining economies of scale in fuel production. Related to these monocultures are the questions and concerns raised by the thought collective with respect to land-use change. At this juncture I point out that some of the most

critical aspects of ongoing and future land-use change are missing from the mainstream discourse. In other words, there exists a reality on the ground that practitioners do not account for. I then address the “promise” of energy-crop cultivation with respect to the revitalization of rural economies, demonstrating the effects of the circulation and distillation of claims in this regard. Finally I investigate the impact of changes in scale on the validity of practitioner maps. This I do within the context of practitioners’ claims that sound sustainability management plans will adequately address any unforeseen consequences arising from large-scale energy-crop cultivation.

In summary, the biofuels discourse *performs* in these four respects: a) through the use of catchy and novel associations, e.g., “energy crops,” “growing fuel,” “grassoline,”; b) through maps that resemble speech acts, i.e., the materialization of the practices implicated by the maps reconstitute reality; c) through unexamined assumptions that shape how the biofuels thought collective constructs maps of natural organisms; d) through scientizing¹⁵ discussions, decisions, and policies that are fundamentally socio-economic, thereby narrowing the horizon of possibilities that practitioners view as being viable alternatives.

Unexamined assumptions, e.g. that technological solutions will automatically bring about social benefits, play a central role in framing the construction of the maps by the thought collective. Such assumptions, by acting as lenses through which practitioners approach their research, can lead to the construction of maps with particularly problematic biases. Some assumptions are specifically linked to matters of biofuels while others, such as the world-as-mechanism paradigm,¹⁶ apply equally to other domains of research. Assumptions (a type of map

¹⁵ Kinchy (2012) describes “scientization” as “the transformation of a social conflict into a debate, ostensibly separated from its social context, among scientific experts [...] science and scientists are frequently considered to be the best possible arbiters of technological controversies, because they are assumed to produce objective, value-neutral assessments that do not favor one social group over another” (21).

¹⁶ The mechanistic paradigm (itself a map of the world)—the world and the life forms within it function as a machine—gave rise to the reductionist approach that continues to dominate science and engineering practices. The basic premise of this approach is that conclusions can be drawn regarding an entire organism on the basis of knowledge produced at the level of the organism’s individual components (Capra 1982; 2010; Beder 2006; Sarawitz 1996). This paradigm continues to grip the imagination despite the fact that a growing number of scientists have come to the realization that the reductionist approach cannot account for synergies within the organism as well as in the relationships the organism has with the larger web of life to which it belongs. The world-as-mechanism paradigm played a significant role in shaping the findings of classical Newtonian physics. Despite a growing body of evidence in physics and the life sciences indicating that an organic or world-as-organism perspective more accurately depicts reality (Capra 1982; 2010; Merchant 1980; Sarawitz 1996), the reductionist approach to knowledge production continues to be the defining characteristic of the scientific method (Keller 1985; Longino 1990). The reluctance to jettison the world-as-mechanism metaphor is its compatibility with particular theories, with the needs of society, and its perceived advantages in knowledge production. “Many historians of science have commented on the congruence of new fundamental

in their own right) are critical because not only do they inform and regulate the thought collective's knowledge production process, but they frame claims and issues at the point of their circulation.

3.1 Mapping as a Speech Act – Assimilation of Plants and Other Life Forms

In what ways do the maps constructed by the biofuels thought collective materialize? The maps guide the research of practitioners by suggesting which questions to raise and how to frame them. Themselves constructed on the basis of the goals of the thought collective, the maps become the lens (or framework) through which practitioners conduct their research.

What are the implications of mapping plants and trees as energy crops? What do practitioners imply when they refer to the non-fruit part of the plant (such as corn stalks or stover) as “residue?” How might cow or chicken manure as a fully commercialized biofeedstock influence the practices centered on livestock breeding and animal husbandry? In certain respects maps can be likened to speech acts that bring about specific actions or effects (Austin 1975; McNair, Paretti, et al. 2010). In this case the “energy crop” and “residue” maps evoke a particular stance toward plants, suggesting they be treated in a particular manner. These maps, constructed according to a particular thought style, do not simply describe what *is*, they hint at what *should be*.

The map—“energy crops”—was constructed according to an already-existing framework: high-yield cash crops. The premise behind energy crops is the same as that for other cash crops: standardization for the purpose of achieving economies of scale. Energy crops may also be considered a form of bioprospecting defined as “the use of scientific knowledge to bring nature into the semiotic realm of capital and, thereby to prepare it for economic valuation” (Toly 2004:47). Fully assimilated into the semiotic realm of the market system, perennial trees and grasses as energy crops will be valued according to their energy-production capacities and ongoing research questions will be formulated accordingly. Bioprospecting may also be thought of as an “ordering forth” of the “standing reserves” for deployment to the energy enterprise.

needs of European societies in fifteenth and sixteenth centuries and the mechanistic model of nature that emerged from this period, swamping organicist and hermeticist alternatives” (Longino 1990:94).

The experimental design and process stand out as particularly noteworthy instances of a framework that influences how the discourse *performs*. The experimental framework through which an organism is encountered influences the response of the organism and what the practitioner actually observes during the course of the experiment. Experimental designs are informed by the goals of the project, and the questions posed to the organism are directed toward those goals (Heidegger 1977; Kohler 1994). As the Heisenberg quote at the start of this chapter suggests, Nature discloses itself to the human gaze, not as Nature per se but rather Nature as exposed to the experimental method. Because experiments are always directed toward obtaining responses to specific questions, these questions evoke or “order forth” (*herausfordern*) (Heidegger 1977) specific responses from Nature. While responses not specific to the goals of the project may indeed emerge as serendipitous findings, their value to the practitioners will likely be assessed according to their potential utility to the endeavor. This instrumental approach however, makes it less likely that the organism will disclose¹⁷ aspects of its nature that are outside the framework of the experimental setup and project goals (Babette 1999; Heidegger 1977; Rojcewicz 2006).

Studies of plants as potential energy crops (using the reductionist approach) risk drawing conclusions about a plant organism that may not apply within the larger ecological niche to which the plants belong. “Switchgrass [...] was selected as a model energy crop by the U.S. Department of Energy [...] because it maintains soil stability, has high yield and high nutrient use efficiency, and requires relatively low inputs of energy, water, and agrochemicals” (Fletcher, Robertson 2011:162). While there is no reason to doubt this claim, note that these practitioners conflate switchgrass with energy crops. They assume that the benefits linked with the perennial plant will be present even after it is fully assimilated as an energy crop.

Extracting organisms from their ecological niche and subjecting them to observation and experimentation are interventions that compromise the integrity of the organism, impacting its responses and behaviors (Hacking 1983; Kohler, 1994). Consequently, laboratory observations can only be partially representative of the organism. The magnification of an organism’s

¹⁷ From a phenomenologist’s perspective (e.g. Martin Heidegger, Merleau Ponty), genuine knowledge gain occurs *perceptively* rather than *instrumentally*. An organism will disclose its being only in a relationship in which the subject-object relationship is fluid and dynamic, and not dichotomous and fixed. This means that the subject (human observer) encounters the object of observation (the natural organism) within the context of its own habitat, observing the organism within its own context. In such an encounter, the organism also becomes an observer. Contrast this with the instrumental approach that extracts the organism from its environment and subjects it to specific goal-oriented questioning.

constituent parts made possible using an environmental scanning electron microscope¹⁸ (ESEM) facilitates the analysis of aspects of the organism not visible to the naked eye. This powerful instrument has enabled practitioners to gain some insight into the rooting structure of perennial grasses, e.g., the capacity of the roots for carbon sequestration and water retention. However, the small-scale close-up view comes at the cost of obscuring other critical aspects of the organism such as the role it plays in the niche to which it belongs.

An organism viewed using an ESEM is no longer the same organism because it must be extracted from its habitat. Because the lab environment is alien to this organism, the behaviors and responses it exhibits in the lab will not mirror those that occur within the organism's accustomed habitat of interconnectedness. Every organism has a gestalt, a unified whole that transcends the summation of its individual parts, and reductionism by its very nature alters this gestalt. The isolation of the organism from its habitat renders an entirely different meaning to its gestalt, making it impossible to fully discern the role it plays within an intricate web of relationships and processes. While small-scale changes may be manageable, increases in scale may bring about a critical mass of changes that lead to emergent phenomena¹⁹ not traceable through conventional cause-effect analysis (Sarawitz, 1996).

Conclusions drawn on the basis of the experiments can be particularly problematic in situations where altered organisms are reinserted into the niche from which they were extracted. This reinsertion does not take place in isolation, i.e., practitioners cannot control for the complexity of variables and relationships that make up the system. Hence, the altered organisms will stimulate other changes as the ecosystem attempts to adapt itself. Although the multiplicity of variables involved will render cause-effect linkages non-traceable, the danger exists that practitioners will be pressured into assuming such linkages in order to propose solutions intended to redress a precarious situation. Multiple interventions over time will lead to the alteration and

¹⁸ This powerful microscope relies on the activity of electrons to produce the image. What the researcher observes is an image (or map) of the organism constructed by the microscope via electron activity. In other words, the researcher's view of the organism is mediated by the map produced by the activity of the electrons. This phenomenon raises the question of the experimenter's regress: how can researchers be sure that the image correctly represents the organism? The way to determine this is to compare it with an accurate image, yet the purpose of the ESEM is to obtain just such an image.

¹⁹ Complexity science "recognizes the process of 'emergence' whereby apparently straightforward natural or artificial systems, governed by apparently invariant and often quite simple rules or laws—a chess board, some computer software, a weather pattern—give rise to intrinsically unpredictable and often highly surprising consequences—a brilliant new offensive ploy, a completely unexpected computer glitch, a typhoon...the concept of emergence dictates that the specific behavior of systems cannot be predicted or comprehended through the process of determining the natural laws that govern the behavior of the individual system components" (Sarewitz 1996:106-107).

domestication of the local ecosystem. The rippling effect will kick in, meaning that the local ecosystem will impact other systems connected to it.

As discussed previously, practitioners have found perennial grasses to be highly advantageous in terms of a robust rooting structure that promotes water retention and carbon sequestration. Additionally these grasses also provide habitat for a rich variety of species. "...replacing annual, grain-based crops with native perennial communities could have positive impacts on biogeochemical integrity and biodiversity, which are two of the major environmental costs of today's agriculture" (Fletcher, Robertson 2011:166). However, as these grasses are increasingly redirected to another purpose, the emergence of standardized practices more suited to high-yield cash crops and quick turnaround will reconstitute them into a very different organism. What will come of the diverse species that share a symbiotic relationship with these grasses? Homogenized organisms fully assimilated into the energy enterprise will impact the ecological niche into which they are inserted. All other life forms within the niche will attempt to adapt themselves to the presence of these 'alien' organisms in an effort to bring about a new state of equilibrium.

The claim that humans have been shaping their *Lebensraum* for centuries through agriculture, while true, is often raised to counter concerns centered on the impact of cultivating energy crops. While such claims may be intended simply to allay fears, they have the effect of closing off dialogue. No practitioner wishes to be portrayed as alarmist. Yet missed by those making the claims is that cultivating energy crops is not simply doing more of the same yet on a broader scale. The full commercialization of perennial grasses and trees on a global scale will involve the transformation of the plants for increased yields and co-transformation of the habitat to which they belong. And the effects of this massive cultivation will compound the effects we are already witnessing with respect to the mass cultivation of crops for food and clothing.

While humans have engaged in extractive and reconstitutive practices for millennia, the sheer size, complexity and force of the tools utilized for such purposes today raises this potentiality to an unprecedented level of urgency. Through scientific and technological innovations, our capacity to reconstitute large segments of the earth has been expanded by many

orders of magnitude.²⁰ Indeed, comparing the human presence on earth today with centuries earlier cannot be reduced solely to population growth²¹. Today's capacity to transform the earth lies outside the scope of conventional quantitative assessments since the tools of modernity have led to a *qualitative* difference in the impact of the human presence.

In previous eras, extractive processes were reasonably localized and in many cases, occurred slowly enough to allow the earth to replenish itself. The simplicity of the tools that required intensive human labor to effect change limited their impact on the ecosystem. While ecosystems did in fact suffer humanly-induced devastation, these occurrences were usually localized to a specific region and took place only after extended periods of time (Diamond 2005). Assuming a growth in demand for biofuels, the development of advanced technologies and techniques for biofuels cultivation and processing will likely increase the impact of the human presence.

The realization that an ecological niche is incompatible with modified plant organisms does not generally lead to a human retreat from those modifications. Instead, further interventions are initiated that ultimately bring about the transformation of the entire niche such that it now suits the desired qualities of the plant. Agriculture, generally speaking, constitutes a well-known example of this phenomenon. The domestication of plants over many centuries took place in tandem with the widespread domestication of the land. How does this project differ from other agricultural endeavors that have preceded it? Lending particular urgency to biofuels is that energy crops will aggravate an already-existing expanse of monocultures brought into

²⁰ Today's human capacity to effect greater changes in shorter timeframes than previously conceivable can be likened to the difference between a sculptor wielding a laser and one, like Michelangelo, wielding a mere chisel (Heidegger 1977). Reputed to have spent months at a time in the marble quarries of Carrara searching out the perfect piece of marble, Michelangelo described his work as 'coaxing forth' a figure that already existed, concealed in the rough within the stone. The artist wielding a chisel plays a maieutic role, "midwifing" forth an already-existing form. The resistance of the stone combined with the limitations of the chisel compels the artist to yield to the warp and weft of the stone. An artist wielding a laser on the other hand, need not be concerned with obtaining the perfect slab of marble since the laser is powerful enough to cut through any resistances the stone may offer. The Incan settlement of Machu Picchu exemplifies the bending and adaptation of an entire civilization to the warp and weft of the landscape that they inhabited. Compared to the tools we have today, their tools were rudimentary and they were compelled to give in to the resistances of the landscape. As such they fashioned buildings and staircases from in situ stones. The settlement stands to this day, having withstood numerous earthquakes over the centuries.

²¹ A growing global population, while not to be discounted, is not the primary factor behind global warming, climate change, and ecological degradation. Reports by climate scientists (e.g. the 5th assessment (2013) of the International Panel on Climate Change (IPCC)) and others indicate that a minority of the world's population—those living in developed nations—is responsible for most of the GHG emissions. Thus, although the aggregate figures for GHG emissions indicate that China emits more carbon than any nation, the per capita figures indicate that the carbon footprint (per person CO₂ emissions) of persons living in the U.S. is the largest of any society. Of course, as more nations attempt to catch up with the West, these statistics will change, indicating that population combined with changes in lifestyle are aggravating the situation.

being during the Green Revolution. Furthermore, the technologies available today make possible the acceleration of this homogenization process on an unprecedented scale.

“Agricultural residue” (e.g. corn stover, forest biomass, livestock manure) connotes something leftover and expendable after the valuable portion has been harvested. This map functions as a rhetorical device by way of convincing people to perceive of the life forms encompassed by the term “residue” as having little or no value. The residue map backgrounds corn stover’s role in soil restoration, while foregrounding its possibilities as an energy input. As indicated by the following, practitioners certainly recognize potential issues with utilizing large amounts of residue:

... some studies suggest that removing even 25 percent of this material [corn stover] from fields will reduce soil quality and decrease carbon content, even on prime agricultural land (Early, McKeown 2009:7).

... removing crop residues can have significant environmental effects, including changes in soil carbon, increased run-off and soil erosion, and increased fertilizer applications to replace (Marshall, Weinberg, et al. 2011:44).

However, the general momentum appears to be in the direction of assimilating these types of organisms as energy crops: “Organic wastes and residues from agriculture, forestry, industry, and households are prime options, as they offer very low GHG profiles, and do not induce risks for indirect land-use through displacement” (Fritsche, Hennenberg 2008:6]

Revaluating stover as an energy crop becomes the logical next step. Henceforth, its value is attributed to its potential as a fuel input. As with the perennial grasses and trees, stover will be appropriated into the semiotic realm of capital (Toly, 2004). The valuable exchange relationship that corn stover has with the soil is an *intrinsic* value (i.e. the meaning the organism derives from the greater whole of which it is a part) and as such, falls outside the realm of economic commodities exchange. But its assimilation into the energy enterprise transforms the stover into a fungible commodity whose value will be determined by the vagaries of the market.

Practitioners promote optimizing the use of residue as a biofuel input because it can avoid, at least in part, the land-use requirements associated with energy crop cultivation (Dale 2006; Fritsche, Hennenberg, et al. 2008; Greene 2006). For example, Fritsche, Hennenberg, et al. (2008) claim that “bioenergy feedstocks could come from cultivating degraded land, and from agricultural, forestry, and other organic residues and wastes, thus relieving pressure on arable land, and respective price and land-use change impacts” (4). However, the same question posed

for the prairie grasses applies equally in this case: how can the consequences of full assimilation into the biofuels enterprise be anticipated? While these biofeedstocks may not require specific allocations of land, their *extraction* will unavoidably impact the land, removing potentially valuable nutritive sources in the process. In the event that stover becomes a valuable commodity, farmers who regularly practice corn and soybean crop rotations in order to restore the soil may be tempted to abandon the practice.

As one practitioner notes: “Scaling up corn stover harvest may result in unacceptable losses of productive topsoil to erosion, declines in surface water quality due to increased sedimentation and eutrophication, and loss of agricultural carbon sequestration capacity and associated increases in GHG emissions from agricultural activities” (Marshall, et al. 2009). Yet the U.S. Dept. of Energy has already embarked on a trajectory that assumes that stover can and will be sustainably extracted: “the Bioenergy Technologies Office has sponsored the redesign of crop harvesting machinery to collect agricultural residues while preventing erosion and preserving soil quality” (U.S. Dept of Energy July 2013:9). The goal of designing the harvesting machine to prevent erosion and preserve soil suggests that corn stover can be extracted innocuously. However, the use of such technologies, particularly on extensive scales, may give rise to other problems.

The foregoing DOE statement appears overly sanguine in its assumption that well-designed technology will have the capacity to address the complexities involved in the relationship between plants and soil. Agriculture has already made massive inroads into the habitat, with many regions completely transformed by it even centuries ago. But the use of larger and more complex technologies collapses the time interval and increases the scale over which changes to the habitat materialize (Wright 2004). Extraction of these residues on massive scales will demand adaptation of the habitat to human intervention over a significantly shortened time interval, increasing the likelihood of non-reversible shocks to the biosphere.

Also under consideration as a biofeedstock is cow manure. Representing nutrient-laden cow manure as “waste” or “residue” creates the impression of a substance without value to which value can be added through its commodification as a fuel input. The waste/residue representation imputes an altogether different meaning to microbial life forms that actually serve a critical soil-restorative role in the ecosystem. Many people in differing regions of the world

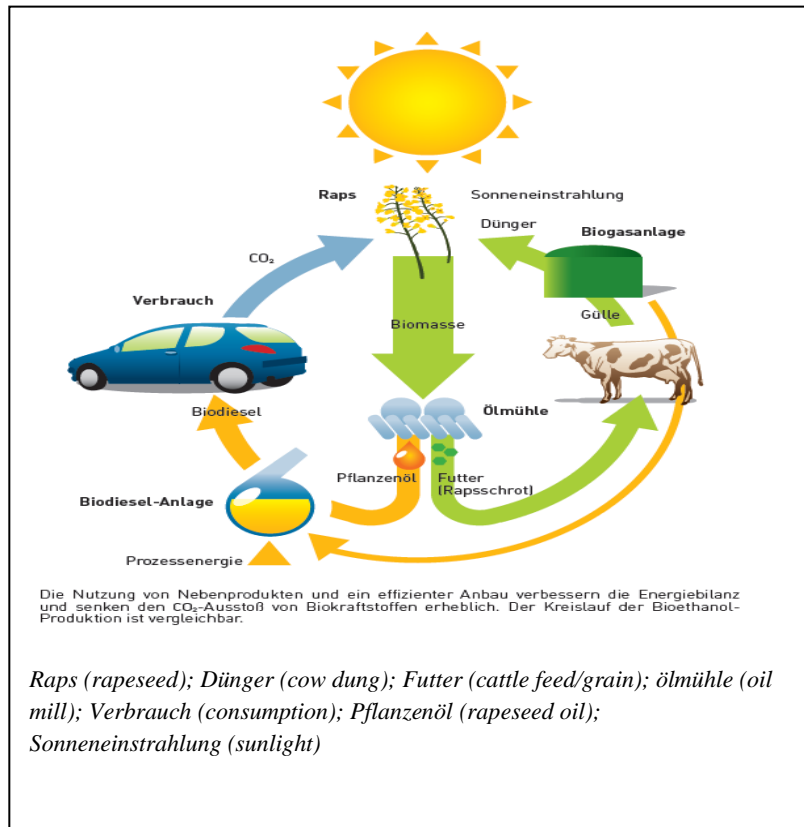
value cow manure not only as fuel but also for its contribution to the soil and land. Yet this seems to be lost on many modern denizens where encounters with cows are limited to the food products available at the grocer.

In the U.S. in particular, the use of cow manure for biofuels, once scaled-up to commercial levels, may stimulate the growth of inhumane CAFOs (Confined Animal-Feeding Operations). Farmers who raise animals using more traditional practices will likely be forced out of business by livestock factories that are able to achieve economies of scale in the collection and sale of the manure. The twin pressures of commercialization of livestock residue and the global rise in the proportion of persons consuming meat may influence the decisions of many farmers in the direction of efficient animal feeding operations.

Many discussions about ‘livestock’ breeding are optimistic, emphasizing the benefits of closed-loop biofuels production systems. “Closed loop production systems have been developed which supply protein rich cattle feed, a co-product of corn ethanol production, to adjoining cattle feedlots and use biogas derived from cattle wastes to supply heat and power to the ethanol plant” (Environmental and Energy Study Institute 2010:15). The following diagram (figure 3.1.1) depicts just such a closed-loop system as it might operate in the European Union. The caption underneath reads: ‘The use of byproducts and an efficient cultivation improves the energy balance and lowers the carbon emissions from biodiesel considerably. The cycle for bioethanol production is comparable.’²²

²² *Raps* (rapeseed); *Dünger* (cow dung); *Futter* (cattle feed/grain); *ölmühle* (oil mill); *Verbrauch* (consumption); *Pflanzenöl* (rapeseed oil); *Sonneneinstrahlung* (sunlight)

Figure 3.1.1 Bioenergy / Biofuels Closed Loop



Source: “in Sachen Bioenergie”, 2010

Used with permission of Fachagentur Nachwachsende Rohstoffe e.V., 2015

Yet, can we be certain that such closed-loop systems will act as a preventative to inhumane animal breeding practices? With the diversion of more and more land to concrete jungles and energy crops, the incentive to turn to the ‘efficiency’ of CAFOs will increase. These are examples of the “knock-on” or “rippling” effects that one form of activity or practice can have elsewhere, even in seemingly unrelated areas. The transformation of grazing animals into tightly quartered grain-fed livestock has already raised concerns in the U.S., both in terms of the treatment of the animals and in terms of human health for those who consume the meat products (Goodall 2005). As available grazing land becomes increasingly scarce, the cost of land will increase, providing livestock breeders with powerful economic incentives to adopt practices requiring much less land.

Reconceptualizing grasses, trees, etc. as energy crops has far-reaching implications concerning the way we relate to these life forms. In particular, assimilating plants as energy crops expands the opportunities for value creation in realizing economic gain. The transition of prairie grasses to energy crops is a commodification process that will involve the enrollment of multiple interests. Each of these interests will have a stake in expanding the enterprise, and once the momentum along a particular trajectory builds, it will be difficult if not impossible to stop it.

3.2 A Monocultured Reality – From Representation to Assimilation and Homogenization

What may be the wider implications of reconstituting switchgrass, trees, forest understory, cornstover, or cow manure to align more closely with the maps constructed by the thought collective? Because maps conceptualize reality in a particular manner, they contain within them the seeds of the normative. By describing what *is* they implicate what *should* be (Merchant 1980). Thus, the mapping of these life forms as energy biofeedstocks implicates practices aimed at transitioning them into homogenized high-yield raw materials. With the continuous *reinscription* of the map onto the reality, researchers will begin to encounter organisms resembling their own human projections²³.

Existing biofuels production has already led to vast monocultures in certain regions of the globe. Increasingly, low-input subsistence agriculture—the most favorable to biodiversity—is being replaced by intensive export agriculture. Demand for biofuels cannot be met within some of the regions—U.S. and European Union—that have the highest demand. As such, much of the energy crop cultivation is taking place in the more vulnerable regions of the globe (e.g. the global South) where many people lack a voice in their own destiny. The clearance of the peat forests in Indonesia to make way for palm oil plantations, while providing job/economic benefits to some, has resulted in massive carbon emissions and the dispossession of people and nonhuman species that depend on these forests for life and livelihood (Agrofuels, 2007).

The cognitive colonization of plant life through representation and reconstitution, extended to global scales, will eradicate essential diversity and variety. Monocultures of plant

²³ Martin Heidegger, describing the effects of the human gaze (the technological enframing) on the manner in which natural organisms disclose themselves alludes to this “hall of mirrors” phenomenon: “It seems as though man everywhere and always encounters only himself” (Heidegger 1977:27). Describing a similar phenomenon, Immanuel Kant observed that: “reason...knows only that which it brings forth according to its own design” (Moltmann 1992:200).

organisms and the gradual homogenization of land-use can lead to “monocultures of the mind” (Shiva 1993) where alternative ways of knowing or doing things are ‘plowed under,’ rendering them invisible. The assimilation of these organisms into high-yield energy crops will impoverish the data scientists collect from them. Since the plants will differ ontologically from their predecessors, the data will increasingly reflect back the thought collective’s energy crop map. Those attributes that made the plant (e.g. switchgrass) attractive to practitioners in the first place—requires few inputs, promotes biodiversity, sequesters significant carbon—may disappear as the plants increasingly resemble their human representations.

In sum, the assimilated plant will no longer bear the ontological imprint of switchgrass. Furthermore, the impacts of the homogenized plant on soil and land may bring about conditions that call for yet more modifications to the organism. The more closely the organisms reflect their human representations, the more they will produce with regularity the phenomena anticipated by researchers. Eventually they will become artifacts of the experimental process: “Experimental creatures are a special kind of technology in that they are altered environmentally or physically to do things that humans value but that they might not have done in nature” (Kohler 1994:6).

The lessons of the Green Revolution must not be lost on biofuels practitioners, politicians or the public. Both the Green Revolution and the biofuels endeavor are tied to the same goal of increasing global quantities of a particular item and both rely on similar agricultural practices for attaining those quantities. They also share in common the good intentions of many of those who promoted them. The technologies that made the Green Revolution possible were intended to make significant inroads into mitigating world hunger if not outright eradicate it. Unfortunately, the Green Revolution ushered in a massive homogenization of seeds and plant life. This destroyed large numbers of subsistence livelihoods, turning many small farmers into dependent day laborers compelled to work on plantations owned and operated by large agribusinesses (Shiva 1993). Suffice it to say, researchers know more today about the consequences of such monocultures and the factors that bring them into existence.

Practitioners advocate the use of plants rich in biodiversity as fuel inputs—“complexity of physical structure also enhances biodiversity, and perennial energy plants have the potential to provide diverse above- and below-ground complexity and thus habitat” (Dale, Kline, et al.

2008:5). Yet simultaneously they establish the cognitive and material foundations for the transformation of these plants into standardized cash crops whose erstwhile biodiversity, owing to its ‘inefficiencies’, will be shunted aside as a costly nuisance. The assimilative language – “perennial *energy* plants”—utilized by these practitioners treats monoculturing as a foregone conclusion.

The language “challenges forth” plants that have disclosed themselves under the human instrumental gaze as “standing reserves” ready and waiting for deployment by the biofuels enterprise (Heidegger 1977). The question requiring more attention from the thought collective is what impact will the domestication of these plants on large scales have on the web of ecosystem relationships they participate in? Practitioners do not deliberately ignore this important question. But because their living space consists, as a general rule, of ordered, technologically-mediated spaces, this question does not solicit the required attention.

Monocultured plant life eliminates diversity, narrows the genetic bandwidth, and degrades habitat resilience. It takes place via plant breeding, genetic engineering, and agricultural practices aimed at increasing yields. This leads to a type of order, not only within the plant itself, but within the larger system to which it belongs. The order (dis-entropy) facilitates management of the plants and increases their yields since the same practices can be applied to all. However, eliminating diversity to create economies of scale will lead to problems (disorder or entropy) in various parts of the ecosystem. Such disorder could be manifested variously as: the introduction of invasive species, loss of soil resilience, water quantity/quality degradation, loss of biodiversity, loss of carbon sinks, loss of subsistence livelihoods, etc.

3.3 The Land-use Change (LUC) Question

The potential for displacing biodiversity by vast monocultures is directly linked with the land-use change question, although concerns regarding monocultures receive less attention. Perhaps this is because mainstream LUC knowledge claims tend to deal with the more immediate aspects of land use such as the allocation of particular parcels of land to food or energy production.

In deliberating over potential problematic LUC, practitioners have raised a critical issue. “As demand for bioenergy grows, so will the areas of land needed for growing biomass feedstocks. The implications of this for other current and potential uses of land to meet competing needs, such as food production, are significant” (Glaser, Glick 2012:4). Both direct (LUC) and indirect (iLUC) land-use change involves a multiplicity of decisions, activities, and variables and thus requires attention at a much larger scale.

Addressing only the issues arising from energy-crop cultivation without simultaneously accounting for other significant factors contributing to massive global land-use change creates an incomplete picture. This in turn may lead to incorrect conclusions regarding land availability and capacity as well as incorrect estimates of GHG emissions stimulated by land-use change. A particularly tricky research problem arises in regard to assessing indirect land-use change (iLUC). Indirect land-use change occurs when one activity on a particular parcel of land replaces another activity that must then seek out a different parcel of land. For example, the cultivation of energy crops on a parcel of land that up until then has been utilized for livestock grazing makes it necessary to locate a different parcel of land for the grazing.

The fast-tracking of the development process by India, China, regions of Africa, and South America, and elsewhere means that demand for road and air transport infrastructure promises to continue unabated. Added to this LUC driver is the increasing demand for agricultural products and the worldwide increase in meat consumption (Myers, et al., 2003; Wiens, et al., 2011) which requires additional acreage to cultivate grains and to provide adequate pasturage for livestock. More land allocated to agriculture and to the breeding/raising of cattle or sheep coupled with land allocated to road/runway construction and urbanization will translate into dramatically altered living spaces worldwide. Landscape ecologists have found that landscape configurations and weather patterns co-shape each other. This means that extensive changes to the land can lead to modified weather patterns. These patterns in turn act on the land, further reconfiguring the *Lebensraum*. Thus, the expansion of monocultures of crops and domesticated landscapes may influence climate change.

“Given the globally rising demand for biofuels, increasing amounts of land will be used for respective feedstock production which could both directly and indirectly result in further habitat loss if forest, grass, peat or wetlands are affected” (Fritsche, Hennenberg, et al. 2008:5).

And in those regions requiring deforestation and/or the destruction of peat bogs, the transition of this land-cover type will generate significant carbon emissions and result in the permanent loss of valuable carbon sinks. Couple this with the melting tundra in Western Siberia where significant amounts of methane are being released (Walter Anthony 2009)—a greenhouse gas with 20 times the potency of carbon dioxide—and the question of land-use change becomes complicated indeed.

The pressure added to the land through energy-crop cultivation may also generate increasing reliance on carbon-trading schemes. Such schemes allow firms to ‘pay to pollute’ by planting trees in regions of the globe thousands of miles from the polluting industry (Beder, 2006). The clearing of a forest to make room for a monoculture of willows or other trees allocated to energy inputs can be compensated for by transplanting the uprooted forest to another region. However, such schemes do not take into consideration the exigencies of the habitat in which the original forest stood nor do they consider the larger implications involved in altering an entire ecosystem.

Destruction of localized habitat cannot be compensated for through the managed cultivation of the same plant varieties in another region. All species are characterized by their situatedness in localized habitats. Therefore, attempts to replicate the affected species in another habitat not only do not compensate for the loss but may give rise to a host of other problems. Too often, discussions about such trade-offs rarely emphasize the social impacts, particularly in those regions of the globe where some livelihoods are themselves characterized by localized ecosystems, e.g., indigenous peoples who engage in subsistence agriculture and/or whose livelihoods may be centered around a rainforest (Abram 1997; Shiva 1993).

In regions of the global south where many communities practice subsistence agriculture, governments responding to the debt-restructuring requirements of the International Monetary Fund (IMF) will bring pressure to bear on farmers to cultivate for export, thus leading to significant changes in agricultural practices. Both direct and indirect land-use change will present problems in this regard. Governments of developing countries, especially those struggling with large foreign debt payments, will likely feel tremendous pressure to allocate more of their own land to energy-crop cultivation, especially as rising global demand for biofuels makes energy crops too lucrative to resist.

Already, problems have been cited with regard to land displacement in the Amazon region:

In Brazil, where biofuels production is an important agricultural industry, land use change from rangeland to cropland is estimated to have a small impact on carbon emissions. However, the indirect impacts could offset the carbon savings from biofuels if displaced ranches expand into the Amazonian rainforest, replacing native forests with pastures. A similar problem could occur where production of sugarcane has moved into areas where soybeans are currently grown; displacement of soybean farming may put further pressure on Amazonian forests” (Duke, Pouyat, et al. 2013:8).

The complexity of the situation makes it difficult and premature to pinpoint specific causal factors. Some blame the growing demand for biofuels (sugarcane ethanol) for impacting indigenous peoples of the Amazon region. In some cases, a double displacement is involved. Those raising livestock get removed from the grazing land they had access to because of the demand for sugarcane cultivation. These herders in turn raze forestland to make room for their livestock. In this case, the displacement of livelihood for one group leads to the displacement of livelihood for another group—those whose livelihoods depend on access to the forest (citations).

The concept of “marginal” or “degraded” land emerges quite frequently within the discourse. It appears most frequently in discussions regarding the capacity of certain perennial grasses and trees to thrive in less-than-ideal soil and/or climate conditions. The primary impetus behind this discussion is the alleviation of conditions that may lead to the displacement of food production by fuel production. Additionally, some practitioners propose that degraded land could be restored and/or improved by utilizing it to cultivate soil-restorative and biodiversity-enhancing grasses.

As stated by these Germany-based practitioners: “The cultivation of biomass on degraded land or abandoned farmland (for economic, political or social reasons) can safeguard against negative indirect land-use change effects from bioenergy development” (Fritsche, Hennenberg, et al. 2008:8). No doubt, use of abandoned land could mitigate competition for food as well as alleviate the displacement of particular land uses to other regions. However, assimilation of perennial plants into the energy enterprise may bring pressure to bear on the availability of such abandoned lands. This could translate into unjust appropriation of the commons or of small landholdings under the mantle of “abandoned land”. The point I make here is that the concept of marginal lands has not been adequately thought out or developed, particularly within contexts where private interests (i.e. property ownership) supersede community interests.

It is particularly challenging to critique this aspect of the discourse because the assumptions underlying it are less clearly discernable. Although practitioners recognize that designations like “marginal” do not lend themselves to facile definitions (Dale 2010; Fritsche, Hennenberg, et al. 2008)—connotations of the concept will differ by regional and socio-cultural context—the overall tenor of the knowledge claims seems to indicate otherwise. Generally, discussions in academic publications specifically addressed to marginal land are nuanced and complex, whereas policy briefs from agencies and some think tanks tend to distill these complexities considerably.

For example, consider this statement from practitioners based at the Öko-Institut in Germany: “Social displacement must be considered carefully, as degraded land might not only harbor endangered species, but also be the only opportunity for landless people to sustain their lives through subsistence farming and extensive herding” (Fritsche, Hennenberg, et al. 2011:10). Now consider this statement from a U.S. DOE publication intended for a broad audience: “Trees and perennial grasses can often be grown on land that is less suitable for conventional crops and can stabilize the soil” (U.S. Dept. of Energy July 2013:7). The first claim is nuanced by the practitioners’ recognition of the potential danger associated with labeling land as “degraded” or “marginal,” whereas the second claim demonstrates the distilled oversimplification that tends to characterize publications intended for a broader audience. I argue that the distilled knowledge claims carry the most weight as far as material effects are concerned.

The marginal-land knowledge claims are framed by the assumption that some kind of consensus can be reached regarding just what constitutes “marginal”. Furthermore, this assumption is undergirded by another: that all ‘stakeholders’²⁴ will assess the value of land in a similar way, agreeing on what constitutes legitimate land-use and which activities add value to the land. Of course, the reality on the ground is considerably more complicated than these assumptions suggest since all of these involve judgment calls based on particular values. Clearly small cadres of experts whose livelihood does not depend on subsistence farming will differ from subsistence farmers in their views on what constitutes marginal land.

²⁴ ‘Stakeholders’ is a loaded term that has been co-opted by mainstream environmental and economic discourses, often to justify World Bank development projects that promote corporate interests at the expense of local populations. If practitioners determine that all stakeholders are in agreement, who (what types of persons) qualifies as a “stakeholder”? How will consensus be reached? Who will be invited into the discussions? Are practitioners accounting for the fact that experts, policymakers, and government officials may use very different criteria for valuing land than those who live near the land and/or who depend on it for their livelihood?

Although the concept of “marginal” will likely be vigorously contested depending on sociocultural and political context, it holds significant popular appeal because it suggests that issues traditionally associated with LUC can be alleviated by diverting the cultivation of energy crops to land deemed low in value. While some practitioners are working toward establishing criteria that qualify land as marginal, the concept is often framed as though it were an already-established given. It is hoped that the allocation of land classified as marginal to energy-crop cultivation will mitigate the food vs. fuel competition by removing pressure from land utilized to cultivate food. The consensus within the thought collective is that, at a minimum, land qualifying as marginal will be land unsuited to growing traditional crops such as rapeseed, corn, sugarcane, or soy (Early, McKeown 2010; Hamilton 2006; Marshall, Sugg 2010). Indeed, discussions regarding cellulosic biofuels often occur in tandem with discussions about marginal land because cellulosic plant forms are able to thrive in regions considered inhospitable to conventional cash crops.

While practitioners of the thought collective come from diverse backgrounds, they all share a similar thought style—they adhere to the same norms of knowledge production. Thus, their judgments about land use and the activities that constitute legitimate land use are judgments that will reflect the thought collective’s system of values. Western norms of forest management provide a suitable case in point of judgment calls made according to particular interests that conflict with other interests. Aimed at assimilating the forest’s resources for human enterprises, the goal is to standardize the forest, making it more efficient and more manageable (Scott 1998; Shiva 1993). As such, certain richly diverse plant species within forests in some regions are considered undesirable since they cannot be standardized to create economies of scale and are thereby classified as “weeds” (Shiva 1993).

A risk posed by biofuels commercialization is that accumulation by dispossession could become rife, particularly within the context of International Monetary Fund (IMF) debt restructuring programs. In such cases, the leaders of countries unable to finance their debt will adopt austerity measures that tend to strip the population of its social safety net as well as privatizing many assets that are traditionally held in common (e.g., water, land).

The pressure to convert more of the commons into energy-crop cultivation will dispossess many small farmers, many of them women, who engage in low-carbon subsistence

agriculture (McMichael, 2009). These farmers, in order to survive, will then have no choice but to migrate to the cities and work in sweatshops or work as laborers on large energy-crop plantations owned and operated by transnational agribusinesses. Already, the expansion of palm oil plantations in regions like Indonesia have led to massive dispossessions of the commons for indigenous people whose livelihoods depend on access to the forests (McMichael, 2009). There is also risk that demand for biofuels may serve as a pretext to invoke *eminent domain*²⁵ (U.S.) or *compulsory acquisition* (some regions in Europe) more frequently.

Energy-crop cultivation, a global rise in meat consumption, and increases in auto/air transport—all of these linked to global population size—comprise three major pressure points impacting land-use change. Note that population is a problem of *consumption*, rather than numbers. The strain on global sustainability results from the increasing numbers of the population who identify themselves as consumers, participating in the excessive consumption that, until recently, was the defining characteristic of Western societies. Because a change in any one of these pressure points will impact the other two, these issues need to be treated together as part of the LUC concern. An increase in land utilized for energy-crop cultivation will decrease the amount of land available for grazing livestock, cultivating crops for livestock fodder and for the construction of transport infrastructure.

Just so, land assimilated into the transport enterprise will increase the pressure on LUC from all three points. Growth in any of the three areas will ultimately result in competition for scarce land, creating incentives to alleviate the pressure through farm factories for livestock and/or genetic engineering to increase the yields of the energy crops. And of course population growth will bring pressure to bear on all three of these points unless deliberate incentives are put in place to change behavior and customs. In the absence of incentives to motivate people to lower their weekly meat consumption, inhumane CAFOs are becoming standard practice, and not solely in the U.S.

²⁵ “The power of the government to take private property and convert it into public use. The Fifth Amendment provides that the government may only exercise this power if they provide just compensation to the property owners.”
Legal Information Institute, Cornell University Law School, http://www.law.cornell.edu/wex/eminent_domain

3.4 Revitalization of Rural ‘Economies’

While many claims are centered on the potential of biofuels to stimulate the rural economy, there is little indication regarding just how this will take place. In particular, those publications intended for consumption by a broader audience tend to hype the association between biofuels production and the blossoming of rural economics. Similar to the promise of “trickle-down” economics, rural economy stimulation is represented as the consequence that will follow from transitioning the fuel economy to biofuels. I refer to rural ‘economy’ ironically because the phrase is misleading. Publications promoting biofuels as a means of stimulating rural economies leave the impression that such ‘economies’ are somehow separate from the larger market system. The cultivation of energy crops ...

...will also have some positive impacts on rural areas. Farmers will gain a new opportunity to market their products so that they can secure their business, or even receive higher profits, which might result in higher spending on consumables. Furthermore, because the processing plants are built near the production sites of the commodities, new jobs will be created (Dautzenger, Hanf 2008:489)

One forms the impression of small closely-knit communities where the “democratic technics” (Mumford 1964) of genuine craftsmanship (as opposed to deskilled labor) define the society. As these practitioners opine: “Biofuels can provide a rather unique developmental advantage to rural and urban communities [...] With interlinked information networks, processing, and distribution capabilities, production can occur at multiple locations, from multiple sources, and with a greater diversity of processes” (Earley, McKeown 2009:13). Decentralized energy systems owned and operated by community cooperatives is clearly a worthy goal. However, the reality is that these rural economies represent a segment of the larger market society, a society in which the market rather than the community is the organizing principle around which society organizes itself (Polanyi 2001/1957). That is, the requirements of the market determine how the society and the relationships that comprise it are ordered.

The scientized claims regarding rural economy stimulation conceal a problematic assumption—get the technology right and all else will follow—that is not likely to live up to its promise. A problem defined technological terms can also lead to situations like this one where an ill-defined concept—rural development—is repeatedly circulated. Through distillation the concept enters the general lexicon and people make assumptions regarding its actual meaning. The problem with such ill-defined concepts is that they can fall easy prey to politicians looking

for ways to appeal to broad constituencies. The longer-term problem with such concepts is that by the time the realization dawns that the promise of rural economy stimulation has not come to fruition, the issue will have been eclipsed by other more pressing issues.

The rural economy question is linked to the commitment by practitioners that biofuels be sustainable in all three aspects—ecological, social, economic. Certainly there are some rural economies that stand to benefit from biofuels, at least from a socio-economic standpoint. However, ground truthing reveals complications in the reality that the maps have oversimplified. For one thing, the concept of rural economy can mean quite different things in differing contexts. In some regions it may refer to small subsistence farmers, while in other areas it may refer to industrial farms located in rural settings. The expectation is that when business is good, the benefits will eventually accrue to other areas of society. However, some things, such as achieving economies of scale, may work against the revitalization of rural economies. Biofuels practitioners recognize that political instruments are essential to making biofuels competitive with fossil fuels, yet such measures could jeopardize rural economies through competition from large agribusinesses. In other words, the very political instruments calculated to make biofuels more competitive with conventional fuels may work against the interests of rural economies.

Claims about economic opportunities for rural economies notwithstanding, the high operational costs of biorefineries and the significant economies of scale required to make biofuels competitive may prove to be a formidable obstacle to genuine revitalization of rural economies. As these practitioners recognize: “The boost may not all go to rural communities; large agro-industrial corporations have also benefited from this support [through policy instruments] for biofuels” (Childs, Bradley 2007:26). How will small farmers’ cooperatives be in a position to own and operate their own biofuels processing plants in face of competition from large agribusinesses that have the capital to create significant economies of scale? The smaller biofuels operations that might be run by a rural farmers’ cooperative will not be in a position to stay competitive with large agribusinesses that can afford the necessary capital investments. Both the U.S. and Germany have witnessed the takeover of significant numbers of smaller biorefineries by large conglomerates such as Archer Daniels Midland (citations).

All the good intentions of stimulating rural economies will run up against the private/public partition that defines the political economy of many regions. “Private,

unaccountable control of production property prevents many people from participating in the shaping of their own and the community's future" (Meeks 1989:57). How can rural community members shape their own communities when private firms, largely unaccountable to the community, are calling the shots? How do rural farmers decide on what is best when the interests of private agribusinesses are shaping the communities priorities? As long as corporations can make decisions and/or take actions that prevail over the wishes of the local community—a growing trend in U.S., Europe and elsewhere—the notion of rural development will not get past wishful thinking.

Do those who promote the idea of 'biofueling' the rural economy intend that biofuels processing plants be entirely owner-operated? And which types—income level—of farmers will benefit the most? Will biofuels commercialization ultimately lead to pushing yet more small-scale farmers out of business altogether? What may happen to those struggling to make a go of organic farming in a country like the U.S. where industrialized agriculture dominates agricultural practices? Will they be forced off the land to make way for energy crops? How will political instruments aimed at farm subsidies be modified to reflect the exigencies of this new economy? How much incentive will a new breed of "energy farmers" have to continue to allocate land to cultivating food crops? These questions are tricky and do not lend themselves to formulaic solutions.

The discourse reduces "rural development" to the provision of jobs without adequate consideration of the kind of livelihood this new industry may impose on rural communities, particularly in those regions where livelihoods depend on surrounding ecosystems. Childs and Bradley (2007) observe that the biofuels sector in Brazil is a major employer. And though work on sugar plantations is quite arduous, sugarcane workers in Sao Paulo receive wages that on average are 80 percent higher than the agricultural sector. Yet, this raises a thorny question: Should practitioners treat this as a beneficial outcome of biofuels commercialization? Interestingly, Childs and Bradley go on to say that

...the ability to create jobs in rural areas, most of them unskilled workers, has made sugarcane plantations attractive, particularly in developing countries. Enhancing rural incomes is particularly appealing in countries experiencing a large-scale migration from rural communities into the cities and struggling to stem the tide (2007:26)

We might ask, for whom are these plantations attractive? Small farmers? Persons who once derived their livelihood from the forest but are forced off the land to make way for cattle

ranchers displaced by sugarcane cultivation? We have only to consider the abysmal working conditions of migrant workers on Tobacco Plantations in North Carolina (Thompson 2013) to imagine what might happen with vast monocultures of energy crop plantations. The provision of back-breaking work in inhumane conditions can hardly qualify as “development” unless only the corporations that own the plantations are the focus of the study.

Dale, et al. (2011) suggest that “by offering employment and income opportunities in developing countries, bioenergy feedstocks can help establish economic stability and thus reduce the recurring use of fire on previously cleared land as well as pressures to clear more land” (1046). Yet, these practitioners do not explain how this will occur, nor do they mention the potential for social dislocation that such “income opportunities” may lead to. Furthermore, this appears to rest on the assumption that the persons affected agree on what constitutes an “income opportunity” and that the goal to increase monetary income takes precedence over other goals such persons may have. Furthermore, the benefits may accrue to only a minority of people in the community, while others may actually end up bearing an unfair share of the costs.²⁶

While the number of available jobs may increase, what kinds of jobs will these be? If displacement of indigenous livelihoods to make way for a palm oil plantation creates job openings for plantation day laborers, from whose standpoint does this translate into rural “revitalization”? In these cases, the domain of biofuels has created significant opportunities for transnational corporations, founded on Western notions of private property, to intervene into the lives of indigenous peoples accustomed to livelihoods founded on the basis of a shared commons. Biopiracy²⁷ by large pharmaceutical concerns has already lead to occurrences of accumulation by dispossession (Peet 2003). Full transition to a biofuel economy could exacerbate these already-existing injustices.

Those livelihoods in some regions that contribute toward the sustenance of a particular community are reduced to terms that make sense only within market-based society where the

²⁶ This is not unlike the situation with fracking. Proponents of fracking promote the practice by citing the benefits to be derived by the communities in which fracking takes place. Generally these are stated in terms of an increase in the number of available jobs. However, what they do not mention is the temporary nature of much of this work nor do they discuss the unequal distribution of some of the most severe impacts of fracking—ground water, streams, ponds permeated by highly toxic mixes of chemicals, the severe degradation of land and soil, the loss of valuable farm animals, etc. See Heinberg, *Snake Oil*, 2013.

²⁷ Biopiracy refers to the way that international corporations gain exclusive property rights to medicinal plants that indigenous groups consider as part of the commons held by the community. The firms patent the plants and then prevent the local population from accessing them. This practice is facilitated by the controversial TRIPS (Trade-Related Aspects of Intellectual Property Rights) agreement formulated by the World Trade Organization and signed in 1994.

market is the organizing principle of society and the arbiter of all social relations and value (Polanyi 2001/1957). Not considered is the value-added to the ecosystem of the low-carbon subsistence farming practiced by people, largely in the global South, who are accustomed to viewing the land and forests they utilize as part of the larger commons. Why do researchers analyzing the carbon fluxes of various biofeedstocks through the life-cycle (well-to-wheel) assessments not consider the value-added by subsistence livelihoods? Including these in the assessments would make it more difficult for practitioners or anyone else to ignore this vital segment of the agricultural sector.

3.5 Impacts of Scale on Planning and Management

Permeating the discourse is the assumption that problems arising from energy crop cultivation can be sufficiently mitigated and managed through sustainable practices (FNR Public Relations, 2009). Biomass production “must not restrict plant production for food, nor should it disturb the ecological balance. Biomass production for energy should therefore be *planned* [my italics] and implemented with great care” (FNR Public Relations, 2009, 10). Of course, *should* be planned implies *can* be planned. Yet so much of the biofuels enterprise relies on interventions in complex systems where planning and management cannot account for emergent phenomena. Furthermore, the scientization of the discourse facilitates the assumption that scientific/technological developments can, like a *deus ex machina*, put things right again.

Practitioner speculations regarding the possibilities of increasing the yields of cellulosic biofuels tend to assume that cause-effect observations made at the experimental scale are easily transferable to larger scales. Informing these discussions are findings that demonstrate the cause-effect relationships of a single component of an organism (e.g. the root structure of switchgrass). “The roots of perennial plants tend to increase soil porosity (the capacity of the soil to hold water) and the amount of water infiltration that can occur at a site [and] are likely to increase the amount of carbon the soil holds, especially in areas where the soil is of relatively poor quality” (Dale, Kline, et al. 2010:7).

Not raised by these practitioners is that once assimilated as full-fledged energy crops, these ‘perennials’ will interact with their habitat as energy crops not as free-standing perennials. Thus, not only are the former perennials grown at increasingly larger scales, cultivation practices

suiting to high-yield cash crops for export are applied, transforming plants, soil, and land. At this stage, not only have the original variables experienced a change of state, but many new variables have been added to the mix. As such, the simple causal relationship observed with respect to the roots of perennials during the experimental phase cannot be relied upon to adequately foresee consequences. As this Germany-based practitioner put it: *‘An agricultural system is not a trivial thing...it works in a complex environment...You must trivialize nature in order to create the lab conditions’* (Interview / Öko)

Perhaps nowhere else is reductionism more evident than in these discussions about planning, management, and control. While breaking systems down into components facilitates “control,” a system is far more than merely a collection of its components and thus manipulation of its components can have dire consequences for the whole system. Unfortunately, the capacity to reduce systems to ever smaller components via more sophisticated instruments creates the false impression that humans can intervene in complex ecosystems indefinitely while managing any consequences that may arise. “To the extent that reductionist science explicitly and inevitably fails to move humanity closer to the understanding of complex systems, it may in fact have the unanticipated effect of reducing freedom by creating the false expectation that the world can be manipulated in precise and predictable ways for the benefit of humanity, based simply upon a knowledge of the minute and intricate mechanisms of nature” (Sarawitz 1996:108).

Yet when dealing with complex ecosystems, the best-laid plans may run amok with the extension of spatial and temporal scales. Sequential segments of space-time enable scientists to deduce cause-effect relationships on a small scale, but “like our ordinary notions of space and time, causation is an idea which is limited to a certain experience of the world and has to be abandoned when this experience is extended” (Capra 2010:182). The research of landscape ecologists continues to reveal more and more about the importance of scale when considering the integration between land patterns and environmental influences (Chave, 2013; Levin, 1992). The farm laboratory research on perennial grasses and other cellulosic biofeedstocks takes place at a local scale and is situated within a localized life-supporting ecosystem. Maps constructed by scientists on the basis of controlled experiments that yield small-scale cause-effect relationships lose their validity at larger scales because they are unable to account for the change in variables and their relationships that take place with increases in scale. (Levin 1992; Wilbanks 2006). In

characterizing relativistic physics Fritjof Capra (2010) makes this observation regarding the impact of scale on the validity of cognitive maps:

Modern physics has confirmed most dramatically...that all the concepts we use to describe nature are limited, that they are not features of reality, as we tend to believe, but creations of the mind; parts of the map not of the territory. Whenever we expand the realm of our experience, the limitations of our rational mind become apparent and we have to modify, or even abandon, some of our concepts (Capra, 2010, 161).

Though not likely to dispute this limitation, practitioners appear to proceed as though conclusions drawn about cause-effect relationships at an experimental scale can adequately guide management schemes and best practices at larger scales and increasing complexity. “With careful land-use planning, crop rotations, and varietal selection, the management of energy crops can also increase profit margins for other farm commodities while reducing environmental effects due to agricultural activities” (Dale, Kline, et al. 2010:3). The underlying assumption is that the models utilized to assess future scenarios and impacts provide adequate information to make reasonable judgments about management schemes at larger scales. Furthermore, practitioners assume that these management schemes will in fact be adhered to. “To assure that the cultivation systems and practices maintain or improve soil quality, the soil organic carbon content of land being used for bioenergy feedstock cultivation or for extracting surplus biomass growth (e.g. grass cuttings from permanent grassland) must be at least maintained” (Fritsche, Hennenberg, et al. 2012:11). And this assumption is buttressed by yet another: whenever and wherever reality defies the modeling assessments, further developments in science/technology can address any issues that may arise.

The cultivation of energy crops extended to a global scale will interact with numerous unknown variables. Computer models that simulate future scenarios cannot possibly account for the full suite of variables and relationships that may interact to bring about complicated emergent processes. At best, the models can provide approximations that enable practitioners to speculate about potential benefits and/or risks. As a recent article in *Science* suggests, the danger arises when practitioners read rough approximations as certainties. The authors note a “disturbing trend in the treatment of model predictions as equivalent to knowledge or data based on actual measurements” (Youngs, Somerville 2014:1096). It seems that the tool’s highly sophisticated

data manipulation capacities ‘seduce’ some experts into putting undue confidence in the results.²⁸

The assumption that sophisticated digital technologies with their powerful data-manipulation capacities confer greater accuracy on the outcome conceals a severe limitation inherent in such technologies. The very process of “mathematizing the gestalt” (Merchant 1980)—i.e. reducing and standardizing natural organisms into “data bits”—required to accommodate the tool translates into the loss of significant amounts of valuable information. Computer modeling, like controlled experiments, compromises the integrity of organisms by interfering with the gestalt of relationships and interconnections that defines them.

Furthermore, computer models require value judgments to be made regarding which variables are most crucial along with which criteria to utilize in making this determination. As indicated below, the variables considered significant are usually those that can be quantified:

...scientists lack full knowledge of the ‘ecological interactions that maintain ecosystems. A particular species may play a key role in maintaining the health of an ecosystem, yet because it appears to play a relatively minor role, remains unstudied. Marine ecologists, for example, study organisms that bioaccumulate contaminants in a way that can be easily measured, and study commercial fish species which need to be monitored for human health reasons. Yet there is no reason to suppose that these are the species that are vital to the ecosystem, or whose health is a good indicator of the health of the ecosystem. This means that it is ‘unreasonable to expect that we can predict the effect of human actions upon marine ecosystems with any accuracy (Beder 2006:57).

The exacting analysis facilitated by the reductionist method makes it possible for scientists to explore and explain aspects of organisms in detail. However, mathematized representations cannot adequately account for the complexity of relationships that make up an ecological niche. Thus, it is not possible to anticipate the consequences that may arise from inserting modified organisms back into the niche from which they were extracted. “Scientific reductionism provides limited knowledge on how to manipulate nature but at the same time creates even greater ignorance in the prediction and prevention of negative side effects” (Huesemann & Huesemann, 2011, 26).

A likely outcome of commercialized biofuels production from switchgrass is intensification of cultivation and this may take several forms: increase of traditional inputs such as fertilizer, genetic modification of organisms to improve plant yields, including manipulation

²⁸ Though beyond the scope of the present study, the impact of these increasingly “seductive” and sophisticated technologies on the rhetorical strategies employed in making scientific claims is an important area for further study.

of the photosynthetic cycle to increase plant biomass, and increased demand for land in general. Although farm experiments have shown some promising results in terms of soil nutrient and greenhouse gas (GHG) balance, under full commercialization, the scale of the endeavor will increase, pushing cause-effect calculus beyond its capacity to make the accurate linkages. At large scales, quantitative increases reaching critical mass may bring about qualitative changes that undermine the findings of the small-scale farm experiments. Indeed, the larger the scale the more complex the causal nexus:

In truth, in the round, real world, there is no such identifiably singular efficient cause, separable from the manifold interplay of the causal dynamic. The actual causal nexus is the chaotic interrelatedness of real events and processes: selectively, deceptively simplifiable, overdetermined from the start, in a chain of conditions and related qualifications (Babich, 1999, 110).

Also to be considered is the impact that global changes have at the local or regional level. Continuing climate change is likely to have significant impacts on local and regional cultivation and harvesting.²⁹ And of course, the impacts will vary by region depending on the prevailing conditions in each area, making the displacement of land use to entirely new/different regions quite problematic. Every region has a unique habitats and life forms which the displaced activity will interact with, and it is impossible to know in advance what kind of emergent processes may evolve.

Complicating matters yet further are attempts at devising interventions to address the consequences arising from incorrect conclusions. Yet the interventions, like the original map, are based on observations and experiments that eliminate critical variables, some of them known, others not: “because experiments always must be designed in a way to eliminate confounding variables, other important interactions within complex systems are necessarily ignored, if identified at all” (Huesemann & Huesemann, 2011, 12).

Sharon Beder (2006) describes three levels of scientific uncertainty—indeterminacy, ignorance, uncertainty—that arise in attempts to understand organisms and/or phenomena that belong to or characterize complex systems. *Indeterminacy* means variables are missing and it is impossible to determine what they are. *Ignorance* refers to a condition that obtains with all researchers: they do not even know when they might be in danger of missing critical variables. *Uncertainty* refers to definitive knowledge claims that fail to take into account the impacts of

²⁹ During the spring/summer of 2013, the southwestern region of the U.S. experienced 1930s dustbowl-like conditions, while the eastern regions experienced record amounts of rain and flood conditions. (citation from Nation magazine)

unknown variables, relationships, and processes. In other words, experiments and computer models lend the aura of certainty to situations that will always be replete with ambiguity and uncertainty.

Caught up in a “Socratic dilemma,” the more scientists study the complexities of the ecosystem, the more they realize how much we do not know and cannot know with any certainty. Even what we know to date can never be absolute because the discovery of new variables, processes, and relationships tomorrow may undermine today’s findings. Since ecosystems cannot be sequestered and isolated to prevent their interaction with other ecosystems, a direct correlation exists between the spatial scale of interventions and the uncertainties they are likely to foster.

3.6 Concluding Reflections

The discourse perpetuates the momentum of the existing agricultural socio-technological regime through the use of representations—e.g. energy crops—that will foster practices aimed at assimilation of plants as high-yield monocultures. Already utilized to an extensive degree to cultivate high-yield cash crops for export, intensive agricultural practices will only be strengthened by the scale-up of biofuels cultivation to regional and global scales.

I have raised the issues associated with naming or relabeling land, plant organisms, etc. Catchall phrases like “biofuels” or “energy crops” subtly convince and persuade through the linking together of familiar concepts. Before long, these phrases enter the mainstream and are distilled by media, press, politicians, and the public. Yet more than simply persuasive turns of phrase, “biofuels” and “energy crops” are objects (in the form of both concept and artifact) constructed by the discourse. Such newly constructed objects become domains around which new opportunities for market-based value creation arise. Corporations seeking new outlets for business and new opportunities to expand their reach can do so through establishing new alliances. For example, the industrial agriculture sector, one of the heaviest users of fossil fuel with carbon emissions exceeding those of the transport sector (McMichael, 2009), is quite dependent on the petroleum industry. Since the petroleum industry produces the gasoline/ethanol blends, biofuels creates an opportunity for the agribusinesses and petroleum companies to make common cause in the production of fuel.

Although this study focuses mainly on liquid biofuels for transport, a fully transitioned bioeconomy includes the bioenergy—power and heating—sector as well as much of the petroleum-based products sector. A few years ago the U.S. Department of Energy (DOE) published a comprehensive report regarding the prospective bioeconomy (U.S. Dept. of Energy 2004) in which an entire section is devoted to bioproducts. Western societies have become so accustomed to elaborate packaging, much of it petroleum-based plastic, that most people do not realize the staggering proportion of fossil fuels appropriated for this sector of the economy. And plastics are just one of myriads of products, e.g. paint, many of the components of laptops, PCs, printers, cellphones, that the DOE report proposes be transitioned to bio-based products.

I raise this because most of the issues discussed herein will be significantly magnified by including the bioproducts sector in the assessments and calculations. Though the processes and end products involved in each of these sectors is quite different, all three will rely on similar inputs at the front end. However, the bioproducts sector tends to be treated separately from the biofuels and bioenergy sectors in terms of environmental assessments and concerns related to land-use change and agriculture. Most of the statistical assessments provided in the reports circulated by the mainstream discourse do not account for bio-based products; they generally include only fuel and power. This means that even the most optimistic scenarios and figures outlined in these reports miss critical figures, thus presenting an incomplete picture. .

An issue warranting further study is the extent to which the *Lebensraum* (living space) influences the construction of maps of reality. Our experience of being-in-the-world shapes the way we view the world and therefore the representations of the world we construct. Cognitive maps constructed by denizens of homogenized modern societies likely differ significantly from those constructed by people who experience more intimate contact with the habitat. Furthermore, the sophisticated technologies utilized in modern settings are implicated in the way practitioners construct the maps.³⁰ Maps constructed within an extensively built-up *Lebensraum* as a backdrop have a greater likelihood of excluding or concealing critical variables and/or relationships of complexity.

³⁰ Computer simulations and models require extensive massaging and preparation of the data to make them compatible with the computer's storage and manipulation requirements. This essentially requires "mathematizing the gestalt" (Merchant 1986), meaning that organisms must undergo several stages of stripping down in order to convert them to "data". This standardization process leads to the loss of rich information that is not amenable to mathematization.

Chapter 4: Ground Truthing II - Awash in a Concrete³¹ Jungle

In this chapter, the ground truthing analysis highlights how the biofuels discourse and the transport socio-technological regime co-shape each other. My analysis is particularly concerned with transport—automobiles,³² aircraft—that requires extensive concrete and steel infrastructures. The progress narrative³³ (and the economic growth model arising from it) has influenced the particular form the regime has taken. In American culture in particular and with recurring frequency in other cultures, automobile infrastructure symbolizes progress. Many in developing nations take pride in their burgeoning concrete jungles, a potent sign of a nation on the rise. Whatever disadvantages may be associated with such a problematic transport regime, these are trivial when compared to the advantages conferred by such a potent symbol of progress.

Because the transport regime frames the *Lebensraum*³⁴ (living space) in a particular way, it influences not only *what* we see, but *how* we see it. This type of regime privileges and marginalizes the landscape such that aspects of the biosphere critical to sustaining life are concealed. The paving over of forests, meadows, and streams proceeds apace on a global scale despite acknowledged threats to the habitat. In those regions where the assimilation of these vital habitats robs people of their livelihoods, the prospect of economic growth stifles all protests. For the fully acclimated denizens of such living spaces, the concrete-and-steel jungle is simply “the way things are.” Just as Mumford (1964) feared, the regime becomes its own *raison d’etre*, with people compelled to conform to its requirements.

I show how the path dependency that characterizes the transport regime all but guarantees that a very limited horizon of alternatives presents itself to practitioners. Practitioner maps, shaped by the framework of the regime, conceal critical variables. This contributes to an impoverishment of the problem definition that biofuels are intended to address. Reduced to fuel

³¹ I utilize “concrete” and the phrase “concrete-and-steel” interchangeably to refer broadly to the extensive infrastructures required to support automobile and air transport, the idea being that growth in automobile and air travel will result in extensive land-use change.

³² Although I focus the discussion primarily on automobiles, where relevant, I also include air transport since the infrastructure required to support this mode of transport involves the surfacing of thousands of hectares of land surface.

³³ The progress narrative pervades modern and developing societies, bearing significant influence on the structure of these societies, all the more so because the narrative remains deeply embedded and unexamined. While beyond the scope of this study to attempt to analyze it in depth, ignoring it would be to leave out a significant explanatory factor in the shaping of the material effects of the discourse.

³⁴ I use “*Lebensraum*”, “habitat”, and “living space” interchangeably throughout this study.

supply-and-demand, the problem definition does not adequately account for cultural and socio-economic issues.

I explain how the privileging of the automobile implicitly informs the biofuels discourse, narrowing the horizon of possibilities to alternatives amenable to technical fixes. Reducing the problem to technical terms fails to address the fundamental socio-economic issues that undergird global demand for auto/air transport. Transportation itself tends to be addressed as a technical rather than a social issue, with many proposed solutions aimed at symptomatic rather than core issues. As such, a continual flood of new ideas and proposals—many of them brilliant when considered purely from a technical standpoint—continues to stream in. Yet all of them, from electric cars powered by bioenergy to extraction of hydrogen from biofuels for use in fuel cells, fail to address the structural issues that make the transport regime problematic.

I raise issues in the chapter that warrant much more depth of exploration and analysis. While beyond the scope of this study to pursue these issues in depth, I draw attention to them because they demonstrate what happens when a complex socio-technological regime permeates the social fabric of society. Perhaps most critically, they highlight the shortcomings of problems defined solely in technological terms. Developing a substitute fuel aimed at mitigating symptoms—carbon emissions and fossil fuel addiction—without problematizing the core issues associated with increasing worldwide demand for automobiles and aircraft will only aggravate those issues.

While the symptoms must be reckoned with, caution is in order as they may distract politicians, policymakers and researchers from addressing root causes. Due to the availability of scientific/technological means with which to address them (at least in the short term), symptomatic issues can have seductive appeal as a low-hanging fruit. Fundamental structural issues, on the other hand, are tricky because they involve values and human attitudes, none of which lend themselves well to “solutions” in the conventional sense of the term.

Land-use change (LUC) comprises one of the major talking points of the biofuels discourse. Omitting the impact of the worldwide expansion of concrete jungles on the land from these discussions is therefore quite puzzling. Even accounting solely for GHG emissions while bracketing all other issues, concrete surfacing stimulates deforestation, and uprooting of grasslands, peatlands, and wetlands, thus generating significant CO² (and in some instances

methane) emissions. Furthermore, the surfacing itself indefinitely seals up valuable carbon sinks, closing off yet more venues for natural carbon sequestration. Factoring in other issues that massive concrete jungles contribute to—hydrological changes leading to degradation of water quantity/quality, soil degradation, destruction of biodiversity, disruption of livelihoods and living spaces—auto-centric transport clearly warrants more deliberation in the LUC discussions. Otherwise, within the context of the growing global demand for cars, all of the precautions that practitioners propose taking to insure sustainable biofuels production will come to naught.

The irony of the transport sector is that despite general acknowledgements regarding its significant contribution to GHG emissions and to dependence on volatile oil reserves, biofuels practitioners do not problematize global growth in demand for automobiles. Because economic growth is an independent variable, it remains outside the problem practitioners are attempting to address. The rapid increase in the number of cars, the increase in miles flown and driven, along with the frenetic pace at which road/urban/runway construction projects are being pursued to accommodate this growth is treated as a presumed necessity. For instance this statement—“In 20 years, the number of passenger cars is expected to double globally” (U.S. DOE 2012:2)—implies that such growth is not only expected but that it is inevitable. The source of the statement (the DOE’s Biomass Program) indicates that the greatest challenge of this growth lies in continuing to provide the fuel that makes it possible.

Transport technology in much of the Western world, and increasingly in regions like China and India, privileges travel by automobile. Even in those regions where the majority of the population does not own or drive a car, large systems of highway/roadway networks and runways constructed in order to accommodate the minority of the privileged who own cars and/or can afford air travel directly impacts the lives of those who rely on walking, bicycling and/or utilizing public transport. These persons are restricted to certain areas and often compelled to navigate structures that inhibit their mobility. In regions that have attained pervasive motorization defined as 800+ cars per 1000 people (Jones 2008), cars have become such a ubiquitous reality that most people cannot imagine existence without them, and in regions notorious for urban sprawl, it is virtually impossible to opt out of car ownership.

Biofuels practitioners render judgments about energy needs that are predefined by society’s existing structure and embedded narratives. They “gaze out at existing society, with

the existing social structure and state of technology” (Balabanian, 2006, 22), and conclude that the only alternatives are those that can be accommodated by the existing setup. Failure to interrogate these means that problem definitions and emerging solutions will always be circumscribed within the framework of these structures and narratives. Indeed, the only way to understand why biofuels practitioners do not address simultaneously the land-use issues raised by energy-crop cultivation and those raised by expanding concrete jungles is to gain insight into the implicit frameworks that shape the discourse.

The subtle, yet powerful influence of the progress narrative is illustrated by an article that appeared in the Spring 2013 issue of the Virginia Tech Research Magazine entitled, “Shrinking the Carbon Footprint with Sustainable Pavement”. The article addressed the processes involved in cement production and layering. While these are not unimportant issues since cement is composed of petroleum, and energy is consumed during the road surfacing process, the thrust of the article was about making the paving process more sustainable, rather than the need to cut back dramatically on concrete surfacing proper. There was a time in recent U.S. and European history when a sky dotted with factory smokestacks belching city-smothering smog was *embraced* as an indicator of progress. Do we not, in a similar vein to our “smog-loving” forbears, embrace automobiles and high-speed multi-lane freeways as signs of progress? The difference today is that we insist that our air and water remain pristine even as we clock more miles on the road and in the sky.

The progress narrative is also manifested in the figures utilized by organizations like the World Bank and the International Monetary Fund to measure the health and wealth of nations in terms of Gross National Product (GNP). This means that producing and selling more automobiles and converting more land surface to transport infrastructure enhances the picture depicted by the GNP figures. Yet the devastating ecological costs of producing 40 million automobiles per year (the current global estimate) and the concrete surfacing of millions of hectares of carbon-sequestering soil, forests, fields, etc. in road and runway construction are all *externalized*. That is, the ecological degradation including permanent loss of species, increased flooding due to loss of soil-drainage surface, and increased atmospheric carbon due to loss of carbon-sequestering habitats, does not show up as an *expense*. On the contrary, because it generates revenue, any cleanup of toxic waste or restoration of degraded habitats resulting from these activities is *added* to—rather than subtracted from—the GNP figures.

4.1-Problematising the Transport Sector as a Discursive Framework

The premise of my argument is that auto/air socio-technological regime functions as an unproblematised framework, implicitly informing the construction of maps. This framework is as pervasive as it is subtle. Transport technologies have molded and shaped the geographies of some regions of the globe so extensively that they have become the ordering principle of society. Everything—forests, rivers, lakes, residential areas, the routine perambulations of the population—must adapt to a landscape embedded by the artifacts of this extensive regime. People are increasingly compelled to orient and arrange their lives according to the dictates of the system (Mumford, 1964; Weber, 2002). Biofuels practitioners decide on alternatives on the basis of what will cause minimal disruption to the existing regime, while the regime proper stays concealed in the background as an unexamined given.

The transport regime encompasses a complex mix of artifacts, relationships, and bureaucratic processes. Andrew Feenberg (2002) uses the phrase “technological arrangement” to emphasize that much more than artifacts are involved. The relationships (between people, institutions, artifacts, processes) that comprise such an arrangement are perhaps its most critical aspect. The concept of an “arrangement” also implies that socio-technological regimes that have become naturalized features of the landscape actually *arrange* and *orient* our perceptions in a particular way:

Technical arrangements institute a “world” [...], a framework within which practices are generated and perceptions ordered. Different worlds, flowing from different technical arrangements, privilege some aspects of the human being and marginalize others. What it means to be human is thus decided in large part in the shape of our tools (Feenberg, 2002, 19).

Two noteworthy issues that emerge in societies in which the technical becomes so pervasive and complex that it orders the social are: a) defining and solving problems falls into the hands of an elite cadre of highly trained technical experts while those most burdened by existing structures have little or no voice, and b) the real costs (to the ecosystem and to livelihoods) are externalized where they tend to fall most heavily on disadvantaged groups, including the nonhuman members of society.³⁵

As highlighted in the previous chapter, potential land-use changes are among the prominent themes comprising the biofuels discourse. Significant investments in the research and

³⁵ Not is the living space of various species fragmented by road networks, but many thousands of animals are killed by traffic.

design of high-yield biofeedstocks that can be cultivated in infertile or arid regions testifies to the importance of this issue. However, most comparisons of biofeedstocks are presented in terms of the greenhouse gas life-cycle assessments (LCAs) that analyze only the cultivation, processing, and use of the fuel while the medium for which the fuel (the car) is produced is left out altogether. Proposals advocating the transition to an electric auto fleet using bioenergy to power the vehicle charging stations fail to take into account the fact that these automobiles require the same extensive infrastructures as conventional vehicles (Environmental & Energy Studies Institute 2012). Furthermore, the electric fleet, just like the existing fleet, will require the extractions and manufacture of the raw materials that constitute the automobile artifact, and these processes severely degrade the *Lebensraum*.

Nothing in such publications cautions that growth in the demand for automobiles is a serious problem requiring attention. Instead, this growth is treated as inevitable, even acceptable, just so long as the it does not continue to be fueled by petroleum. This is *not* to say that the issue is not raised by other experts speaking from alternative discourses, but rather that its absence from the statements circulated by prominent practitioners situated in the most influential institutions in both Germany and the U.S. is quite noteworthy. Embracing the path dependencies of the prevailing transport regime as unalterable givens while pursuing the transition to biofuels will only exacerbate the conditions biofuels are intended to mitigate.

Germany has a significantly more robust public transport system than the U.S. The inequities of political economy faced by Americans living amidst urban sprawl are somewhat mitigated in a nation whose infrastructure provides more access to alternative travel venues. Though many Germans complain about delays and cost, one can travel throughout various regions of the country, and other countries in Europe via rail and within and around major cities and urban areas using the local streetcar system. Still, there are regions in Germany with little or no reliable rail access, making it difficult to navigate these areas without a car. A growing number of people residing in Germany are opting to drive their own personal vehicles despite comparably much higher gasoline prices.³⁶ Increasingly, urban centers in Germany are designed with automobile infrastructure incorporated into the plans.

³⁶ Increasingly, urban development in countries like Germany reflects the growing demand for private automobile ownership. Germans heading out onto the famous Autobahn destined for their favorite vacation spots encounter backups and delays not experienced a few decades ago. Gone are the heady days of ‘break-neck’ speeds by which the Autobahn gained its fame.

Practitioners of the biofuels thought collective interpret reality, define problems, and set priorities against the backdrop of a society immersed in concrete-and-steel jungles. This problematic structure does not enter into their problem definition precisely because it has receded into the background as a naturalized given. As such, it functions as a lens through which reality is perceived and interpreted. Another important consideration is the growing propensity to associate increases in motorization with progress.

American suburbia provides a particularly noteworthy illustration of how regional geography can have significant transformative impacts on the horizon of available possibilities. Those not familiar with the complexities involved in the decline of rail transport in the early twentieth-century tend to assume that America's significant land mass played a key role in determining the trajectory of transport in favor of the automobile. However, as some historians (Jones, 2008; McCarthy, 2007) point out, the contingencies involved were quite complex, involving the interaction of several phenomena. Beginning as early as the 1920s, home and auto ownership were embraced as core values by many Americans. Henry Ford's \$5/day wage made it possible for working class Americans to own automobiles, and he is credited with 'jump-starting' the consumer society as we know it today.

After World War II, a combination of factors motivated the transition of much of the U.S. population from the cities into suburban areas³⁷. One of these was a strategy aimed at reducing urban vulnerability to nuclear attack (Greer 2013; Tobin 2002). Other significant factors included the affordability of suburban homes and the availability of credit to purchase homes and vehicles. Many corporations also found it advantageous to relocate to the suburbs. This migration of people and corporations to the suburbs combined with the motorway construction to accommodate their mobility transformed the geography of the nation. As the landscape became increasingly embedded with road and highway infrastructure, alternative forms of transport requiring different infrastructure became more difficult to envision. Indeed,

Indeed, the German government found it necessary to stagger school summer vacations across the different Bundeslands (federal states) to mitigate unbearably lengthy traffic delays on the main motorways that occur when everybody heads out for their holidays at the same time.

³⁷ "Historians generally recognize postwar suburban expansion as the result of rapid economic growth, the population boom, and affordable real estate prices, which drove people into the suburbs...But, thus far, little has been said regarding why the government was so interested in encouraging such expansion...After using atomic weapons in Japan and witnessing the beginning of the Cold War conflict with the Soviet Union, US experts became keenly aware of the vulnerability of its densely populated cities as targets of atomic attack, and advised that strong measure be taken to disperse urban populations" (Tobin 2001:1-2,4).

this situation of urban sprawl created conditions in many regions of the U.S. that made it next to impossible to function without a car. The transformation of the geographic horizon led ultimately to a transformation of the cognitive horizon of possibilities. The landscape of the region had changed and along with it the possible alternative life-worlds that people were able to envision.

The crossing of the threshold of mass motorization—defined as 400 cars/1,000 population—achieved in 1958 was due to a combination of factors (Jones, 2008). In the first half of the twentieth century, a number of factors contributed significantly to a transport sector biased toward automobiles. These included the availability of credit for auto purchases, the abysmal financial state of the various privately-owned streetcar companies, the income tax law as embodied in the Sixteenth Amendment of the Constitution, and the association of automobile ownership with status, independence and freedom by many Americans. Mass motorization was reached even before the Eisenhower Interstate Highway Project got underway. While the highway project did not *cause* Americans to choose automobile travel over other alternatives, it was certainly an influencing factor in the transformation of the suburban landscape and the horizon of possibilities made imaginable by that landscape.

After mass motorization had been attained and the interstate project was well underway, significant changes in the geography of the nation biased transport choices in favor of the automobile. The transformation of suburbia through the relocation of many Americans from the cities, had a profound impact on the way the Interstate Highway system ultimately took shape. Built to service a suburban auto-oriented public and the industries that employed them, the system ultimately contributed to technological “lock-in” turning car ownership into a necessity for those living in these areas (Jones 2008:181).

The desire for automobiles shaped the emergence of a concrete jungle whose drastic reshaping of the landscape made automobile ownership a necessity in many regions. The U.S. reaching pervasive motorization (800-plus motor vehicles per 1000 people) as early as the 1980s (Jones, 2008). Germany, at approximately 650 motor vehicles per 1000 people has surpassed mass motorization and is well on its way to pervasive motorization. China has transitioned from a nation that up into the 1980s permitted only businesses and government to own vehicles, to a nation where the presence of privately owned vehicles is commonplace and demand continues to

rise. In India, traditional forms of transport such as rickshaws, animal-drawn carts, and bicycles have been forced to give way to massive networks of high-speed motorways. This has led to the disruption of livelihoods for many people who rely heavily on these more rudimentary forms of transport and who are thereby excluded from full participation in the society because they cannot afford an automobile.

4.2-Spatial Orientation & the Onset of Landscape Amnesia

Transport artifacts become deeply imbricated with a particular setting once the surrounding habitat adjusts and adapts itself to the intrusion. At this point, the habitat is transformed completely, with many of its former characteristics taking on new forms. A distinctively valuable way of conceptualizing a landscape transformed by embedded artifacts is the *milieu*:

The milieu is a set of natural givens—rivers, marshes, hills—and a set of artificial givens—an agglomeration of individuals, of houses, etcetera. The milieu is a certain number of *combined, overall effects bearing on all who live in it* [my italics]. It is an element in which a circular link is produced between effects and causes, since an effect from one point of view will be a cause from another (Foucault 2007, 21).

Foucault’s distinction between “natural” and “artificial” givens is contestable given the difficulty in pinning down a descriptor like “natural” to a single meaning³⁸. After all, what some assume as natural in one context might be deemed artificial in another context. However, I believe that his statement regarding the “*combined overall effects bearing on all who live in it*” is the fundamental point of his characterization. I distinguish between naturally- and humanly-constructed environments in order to highlight differences between land cover such as forests, rivers, and fields and land cover that is unmistakably the product of modern high-tech interventions. My distinction does not detract from the fact that such humanly-constructed edifices interact with neighboring forests, fields, and rivers, shaping them in the process.

Embedded transport technology, in conjunction with the administrative and bureaucratic processes required to maintain it, creates a distinctive milieu in which artificial givens combine with natural givens, and the combined overall effects of these givens frames and molds the lives

³⁸ For instance, what about a beaver dam? Surely, this is an artifact that was constructed for a particular purpose. And what about humanly-constructed edifices such as Machu Picchu that were designed to accommodate the warp and weft of the existing landscape? Would we refer to these as ‘artificial’ or ‘natural?’ And if something constructed by humans is ‘artificial’, does that mean that humans are other than a species ... that they are not part of nature?

(human and nonhuman) of all who participate in it. All participants in the milieu are impacted, be they automobile drivers, bicyclists, walkers, or users of public transport. Both human and nonhuman participants suffer restrictions on their choices and are compelled to adapt themselves to the structure in order to survive. Of course, biofuels practitioners and the thought collective they belong to are among those affected by the milieu. It only follows therefore that a naturalized transport arrangement would frame the discussions about fuel sources yet never enter into the discussions as part of the problem the practitioners were attempting to define.

Landscapes and habitats accommodate themselves to these artificial intrusions, and in some cases they blend in so well that they eventually shed their artificial distinctiveness and appear as though they had always been part of the landscape. In this dance of nature and technology, nature accommodates itself to the technological intrusion even as technological artifacts take on features of the habitat that make them appear as though they belong there. Stream/river hydrology, riparian habitats, soil chemistry, water quantity and quality, etc. adapt to the new conditions, and are transformed in the process.

The artifacts and contrivances that initially resulted in disruption to surrounding ecological processes are, through time and adaptation, absorbed into the milieu reconstituting its permanent features. For example, a road network embeds itself within the landscape to such an extent that the warp and weft of the land changes along with the hydrology and soil composition by which the region was formerly characterized. As a new feature of the milieu the road network alienates the landscape, making what once appeared natural look out of place. But with the passage of time and the accommodation of the surrounding habitat to the intrusion, the roadway eventually sheds its contingent moorings and takes on the aura of permanence.

The resilience of a habitat in accommodating itself to technological artifacts complicates matters by making it difficult if not impossible to distinguish between the artificial and the natural and by significantly complicating restorative efforts. Attempts to extract the artificial aspects and return the setting to its previous state may result in harming the habitats that have formed around the altered setting. For example, constructing an extensive network of highways requires damming up rivers, the redirecting of streams, deforestation, and extensive carving up of the landscape. Significant ecological destruction and degradation result, with aspects of the former habitat irreplaceably lost. Over many decades, the system of roads and bridges melds

into the surrounding landscape, and new habitats are formed around it. As such, much of the landscape that appears as a natural given has actually been extensively transformed through embedded transport infrastructure.

Demand for more cars translates into additional transport infrastructure. At the same time, a milieu increasingly characterized by embedded transport infrastructure makes automobile ownership a necessity in many regions. The largest urban renewal project in history—the Boston Big Dig—undertaken to relieve the central artery which far exceeded its intended capacity of 75,000 vehicles (Bushouse 2002), illustrates this circularity. The original central artery stimulated more auto use which ultimately led to a massive expansion project, and it remains to be seen how quickly this highly expanded highway system will stimulate an increase in motorization to the point of once again filling beyond its intended capacity. The combined overall effects that bear on all who live within this transformed milieu *orients* and *orders* people's daily lives in a particular manner, influencing not only what they see but how they see it. Many denizens feel caught in the grip of an Iron Cage³⁹ that imposes upon them a particular life-world chosen by others.

Perhaps most critically, an extensively contrived milieu transforms the horizon of possibilities that people deem as being within reach. Such a milieu eventually becomes normalized into a state of “that's-the-way-things-are”, dramatically altering a person's experience of being-in-the-world and significantly shaping their perspective. Ultimately “landscape amnesia” (Diamond 2005) sets in, and the occupants forget altogether their experience of the prior milieu. Exacerbating the amnesia is the impoverishment of research data that results from the expansion of concrete jungles and the homogenizing impact they have on rich, variegated landscapes. Also known as “creeping normalcy,” landscape amnesia refers to conditions under which the “baseline standard for what constitutes normalcy shifts gradually and imperceptibly” (Diamond 2005:432). In other words, gradual alterations punctuated with erratic fluctuations (e.g. the Boston Big Dig, China's Three Gorges Dam) tend to conceal a changing

³⁹ Max Weber (Maley, 2004; Weber, 2002) coined the “Iron Cage” as a metaphor to characterize the notoriously inflexible conditions in society created by modern forms of administration. Modern societies are distinguished by their reliance on highly complex systems of bureaucratic administration that impose a particular modus operandi on members of the society. Such systems require multiple layers of bureaucrats and associated processes in order to oversee the system and insure its efficient operation. Weber was concerned about the potential for complex bureaucracies to curtail human freedom and development because ultimately, ends are lost sight of as means become so all-absorbing that they become ends in themselves (Maley 2004; Mumford 1964; Weber 1946). “Some of Weber's most famous passages are full of foreboding regarding the potential for bureaucracy to diminish the sphere of individual freedom and action” (Maley 2004:73).

yearly average. It should come as no surprise therefore that a technologically-imblicated milieu serves as an unproblematized framework that shapes the discourse.

As discussed previously, the combined overall effects of the natural and artificial givens of a milieu has effects that bear on all who live within it. A person's self-understanding is formed through the relationship they have to the world around them. Many indigenous peoples understand this relationship in ways that strike denizens of modern societies as odd. The spatial conditions of existence—be they highly developed societies with vast networks of highways, runways, and parking lots, or a remote village where livelihoods depend on intimacy with the habitat—have a profound impact on meaning making and knowledge production (Abram 1997). Spatial configuration plays a critical role in orienting and organizing people's perceptions and in shaping their symbolic universe, all of these informing data collection and knowledge production processes.

In his book *The Spell of the Sensuous*, philosopher David Abram argues that modern humans, through extensive technological mediation, have lost touch with the “direct sensuous reality” which makes us human. He describes how the development of the alphabet and writing radically transformed “the intertwining of earthly place with linguistic memory common to almost all indigenous, oral cultures” (176). He speaks of the landscape as possessing a “moral efficacy” for oral cultures, meaning it has the power to “ensure mindful and respectful behavior in the community” (156). Whether we are accustomed to “feeling the earth beneath our feet” as we walk through the forest or traveling at high speeds through landscapes buttressed by concrete and steel is no trivial matter since it significantly impacts the way we perceive the world and our place in it. Due to extensively artifact-embedded living spaces, denizens of highly developed societies are removed by several orders of magnitude from the habitat that sustains them, robbing the landscape of its power to ensure mindful and respectful behavior within the community. In many modern societies, mediation of existence by technological artifacts increases dramatically with each succeeding generation. There is a palpable sense in which each successive generation in such societies experiences the surrounding habitat and supportive ecosystems at a much

further remove than their predecessors. As such, with every succeeding generation comes a dramatically altered experience of being-in-the-world.⁴⁰

Because our living space serves as a backdrop from which we view the world and from which we produce knowledge, it has a decided influence on the maps constructed by practitioners. The particular spatial orientation formed by a landscape significantly mediated by transport infrastructure artifacts highlights some features while concealing others. Westerners participate in a predominantly visually-oriented culture with a short time-horizon. They give priority to issues that lend themselves nicely to solutions with large short-term paybacks but whose benefits often diminish, and may even lead to harm, when the time horizon is extended into the longer-term future. As a consequence, whatever is foregrounded by the milieu stands a better chance of making it onto the “radar screen” of public concern and priorities. The more subtle features and nuances of the landscape fall out of sight and thereby out of consciousness. Biofuels for transport become the most expedient solution viewed from the perspective of a spatial orientation that privileges extensive road-and-steel works to support vehicular and air traffic.

As Max Weber and Lewis Mumford emphasized, albeit in different ways, the extensive bureaucracies required to support complex systems create a situation in which the people whom the system was purportedly intended to serve end up comporting themselves to the requirements of the system. In effect, they become cogs in a machine (Mumford, 1964) or prisoners in an Iron Cage (Weber, 2002). In other words, in order to participate in a highly modernized, highly bureaucratized society, people gradually give up their agency to bureaucratic forces over which they have little or no control. To an increasing degree, time and effort are expended on meeting the requirements of the system rather than in enterprises that contribute to human self-development. This last point is what Mumford and Weber were so concerned about, i.e., that complex technologies coupled with the bureaucracy required to maintain them tend to dehumanize.

The needs and purposes of the community get subsumed by the requirements of the transport infrastructure, including its administrative bureaucracy. Interventions are limited to

⁴⁰ Phenomenology views knowledge as arising from direct experience of the world. The sense of being-in-the-world emphasizes the embodied, sensuous contact with the world. Gaining knowledge of the world is a perceptive rather than an instrumental endeavor.

those which will cause as little disruption as possible while maintaining system status quo. Purpose is increasingly determined by the needs of the system rather than by the needs of the people the system is purportedly intended to serve (Mumford, 1964). Interventions that would better serve the human and nonhuman members of the community are rejected out-of-hand because they would disrupt the status quo. Rational policy becomes prey to the “sunken-cost effect”⁴¹ a phenomenon that arises when “we feel reluctant to abandon a policy (or to sell a stock) in which we have already invested heavily” (Diamond, 2005, 432). The spatial orientation formed by this pervasive infrastructure limits the horizon of possibilities, making it all but impossible to imagine anything radically different to the prevailing structure.

The overall combined effects of naturally- and humanly-constructed givens can be observed in the biofuels discourse circulated by dominant agencies and institutions. While the transport infrastructure is perhaps less pervasive in the Germany than in the U.S., there is no reason to doubt that the biofuels discourse circulated from German institutions is significantly shaped by the increasingly central role played by automobiles in the lives of German citizens. While Germany’s landmass limitations impose natural limits on roadway construction, the increasing centrality of auto ownership can be seen in the construction of homes, parking lots, and shopping malls that accommodate cars. And of course, it is quite likely, if not inevitable, that the growing pervasiveness of auto-privileging infrastructure in nations such as China and India also provides an implicit framework for the discourse emerging from German and U.S. institutions.

4.3-The Efficiency Conundrum

The nineteenth-century British economist Stanley Jevons observed an interesting phenomenon with respect to efficiency gains: “It is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to diminished consumption. The very contrary is the truth” (Jevons, 1895, cited in Huesemann & Huesemann, 2011). Irrespective of where efficiency gains are realized—in raw materials extraction, in production, in transport, etc.—they generally

⁴¹ John M. Greer (2013) uses the phrase “the psychology of previous investment” (coined by James Howard Kunstler (2005)) to characterize the “sunken cost” phenomenon: “Societies, like individuals, make material investments in a variety of projects and tend to make comparable emotional investments in those same projects. Even when a project of this kind has failed according to every objective criterion, a society will quite commonly continue to pursue it, even when that requires the diversion of scarce resources from objectively more important tasks” (59).

induce price reductions in the final product *ceteris paribus*. And price reductions, particularly for a product in high demand, stimulate increased consumption. Referred to as the “Jevons paradox,” and more commonly as the “rebound effect,” this phenomenon is quite commonplace, with numerous cases on record that testify to its reality.⁴²

Biofuels researchers and developers are striving to achieve efficiency gains in the conversion of cellulosic feedstocks to biofuels so that the price at the pump will be comparable to that of oil. But as similar cases demonstrate, this will drive up consumption rather than putting a damper on it. According to the International Energy Agency “overall auto fuel efficiency improved by twenty percent from 1974-1998 in IEA countries but this was accompanied by a more than forty percent rise in consumption of auto fuel” (Huesemann & Huesemann, 2011). Additionally, there have been various tax credits and other government subsidies made available in the U.S., Germany, and elsewhere in order to make commercialization feasible. These subsidies to biofuels producers translate into lower prices at the pump.

There are enough examples from recent history to suggest predictable responses to fuel price fluctuations. In 1979, for instance, Congress extended price controls on domestically produced oil as a “rebate” to compensate for oil industry price gouging and windfall profits in 1973-75 (McCarthy, 2007, 223). The impact of this was to keep gasoline prices lower than they would have been, thereby removing the incentive for Americans to drive smaller, more fuel-efficient vehicles. Contrary to predictions several decades ago, Americans continue to opt for larger, less-fuel efficient vehicles such as Sports Utility Vehicles (SUVs) and light trucks.

In 2008 with the sudden spike in oil prices, vehicle miles traveled (VMTs) and air miles experienced a decrease, as people cut back on unnecessary trips and/or sought alternative forms of travel. But as soon as oil prices began to decrease and stabilize again, VMTs and air miles once again manifested an increase. Despite volatile oil price fluctuations experienced in 2008-2009, Americans in particular did not fair so badly since oil exploration, extraction, and processing continues to be highly subsidized by direct and indirect subsidies (Myers, 2001). Yet

⁴² An example of the Jevons Paradox operative in healthcare: Among the reasons cited for runaway healthcare costs in the U.S. is the overuse of high-cost procedures such as colonoscopies that, due to innovations in technology, are easier and safer to perform and are now available on an outpatient basis. Previously a more complicated, cost-prohibitive procedure, colonoscopies were available on an inpatient basis only, and were therefore prescribed by physicians only when absolutely necessary. Today, such procedures are increasingly prescribed on a routine basis despite the availability of cheaper, less invasive, equally effective tests, and they are driving up the nation’s healthcare costs (Rosenthal, June 1, 2013).

another significant subsidy is borne out by the large U.S. military presence in volatile oil regions of the Middle East, established in part to insure a secure and steady supply of oil. Oil is subsidized by other nations as well, including Russia, China, and many European nations. Attempts to make biofuels competitive with oil are complicated by these subsidies, particularly the indirect subsidies that are disguised in the form of externalities such as carbon emissions resulting from petroleum extraction, refining, and utilization.

An unproblematic growth in auto/air traffic risks negating the beneficial contributions of biofuels—CO² emissions mitigation, energy security/independence, stimulation of rural economies. Growth in vehicle production and ownership translates to more vehicle miles traveled (VMTs) and this means yet more concrete-and-steel infrastructure to meet the demand. Vehicle/air miles traveled tend to correlate with the vagaries of petroleum prices. Commuters and travelers the world over respond to price fluctuations in a predictable manner: when the price goes down, people tend to deliberate less thoughtfully on their travel decisions and clock more auto/air miles, and own/drive more vehicles.

The correlation between travel choices as indicated by auto/air mile statistics and petroleum prices should serve as a critical red flag to biofuels practitioners. As discussed in chapter two, a recurring concern amongst practitioners is making biofuels competitive with oil. Yet as recent historical correlations between travel choices and fuel price demonstrate, attaining such a goal may have perverse consequences. On the basis of this recent history, we can surmise that the availability of a “clean” fuel source at a reasonable price that promises to cut back on carbon emissions and to make it possible to move away from oil dependency, will stimulate an increase in VMTs and air travel. Indeed, the correlation observed with lowered fuel prices may be exacerbated by psychological factors—the belief that one can drive or fly “guilt-free”—likely to be associated with biofuels. Thus the increase in miles driven/flown amongst the existing population will be compounded by global population growth as well as by the growth, in many developing nations, of private automobile use.

Also important to consider is that liquid biofuels consist of a mix of biofuel and fossil fuel, with the proportion of each varying by region (in the U.S. E10 fuel consists of 10% ethanol and 90% gasoline, while Brazil uses an E20 blend). As demand for biofuels increases, there will be a continued need to rely on fossil fuels until combustion-engine technology is able to

accommodate nearly 100% biofuel and/or an electric auto fleet powered by bioenergy-powered charging stations is fully implemented. There is also the not unlikely scenario of the supply of biofuels unable to keep up with the demand. In this case, the default response will be to turn to fossil fuels to narrow the supply-demand gap. Due to the depletion of conventional sources of oil (i.e. the geologically low-hanging fruit), oil corporations are turning increasingly to unconventional “tight” oil and gas sources as evidenced by Canadian tar sands extraction and fracking. The extraction and refining processes required for these unconventional sources exceeds by many times the ecological devastation associated with conventional extraction practices. Already, 60 percent of the oil utilized by the U.S. comes from the Canadian tar sands where millions of hectares of Boreal forest and the livelihoods of thousands of indigenous peoples are threatened.

The likelihood of the Jevon’s paradox materializing once biofuels have been commercialized and are selling at competitive prices brings the economic objectives of biofuels into question. As discussed in chapter two, the full commercialization of second-generation biofuels runs up against some technical challenges that translate into higher prices at the pump. One of the primary goals therefore is to develop technologies that make it possible to produce biofuels that can be priced competitively with fossil fuels. However, given the clear evidence that the Jevon’s paradox is operational with regard to petroleum prices, it seems that this goal might be misplaced. Furthermore, providing a cheap fuel that is also better for the environment may inadvertently provide an added stimulus for clocking yet more auto/air miles.

Another unproblematized issue concerns the environmental impacts of the accelerated manufacture of numerous vehicles and aircraft. According to the logic of Stanley Jevons, the availability of a fuel with a competitive price tag, particularly one that people perceive as enabling “guilt-free” travel will stimulate demand for vehicles and aircraft. Coupled with ‘standard-of-living’ increases in various regions of the world, this increasing demand will have significant social and environmental impacts as various industries race to meet the demand for vehicles. The land-use impacts of manufacturing these artifacts, including extraction, transport, and processing of raw materials will be immense. Even were global consumption rates to remain frozen at current levels, we would still be faced with significant greenhouse gas (GHG) emissions and land-use degradation as a result of vehicle and aircraft manufacture. Already

much controversy surrounds the mining of bauxite⁴³ (used in making aluminum) which devastates the landscape and leaves behind highly toxic mine tailings (Amnesty International 2010).

The prospect of perennial grasses and trees contributing to soil enrichment and biodiversity cannot be considered in isolation from the dire prospect of extensive land, soil, water, and biodiversity degradation resulting from the mining of materials required for the production of road vehicles and aircraft. Neither should practitioners study the impacts of energy crop cultivation on the land without also considering “the broader scale effects of landscape connectivity and habitat fragmentation, and, specifically, the effects of roads in fragmenting the landscape and interacting with landscape processes” (Coffin 2007:397). Also not trivial are the animal populations decimated by vehicle collisions. Even if practitioners could overcome the obstacles to indirect land-use change (iLUC) assessment (raised in the previous chapter), such assessments would still not account for the significant sources of iLUC I raise here. Why? Primarily because the concrete jungles serve as a lens through which the biofuels thought collective perceives the problem and therefore they do not enter into the consciousness of the collective. To summarize, studies aimed at mitigating the undesirable impacts of energy crop cultivation that do not also consider these closely related land-use issues will produce maps that do not adequately account for the full impacts of this energy source.

The question that presses is this: shouldn't something be done in the way of incentives (and/or penalties) to reduce the ‘epidemic’ of automobiles that seem poised to overrun yet more of the world’s dwindling surface area? If the following prediction materializes, not only will the benefits attributed to biofuels be negated, a host of other issues will materialize:

In 1900 there were only 8,000 cars in the United States. Today there are over 160 million. Worldwide the automobile industry produces 40 million new cars every year, with 530 million already in use ... The number of autos worldwide is expected to double to more than a billion within the next twenty years (Huesemann & Huesemann, 2011, 29, 99)

⁴³ Bauxite is used to produce aluminum and as auto manufacturers transition from steel to aluminum as a primary ingredient of the auto body, we can anticipate that the already-significant land degradation resulting from bauxite mining and aluminum processing to worsen. Note this statement from a recent issue of the Wall Street Journal: “Ford Motor Co.’s decision to employ an aluminum body for its coming 2015 F-150 pickup truck is proving a trigger for an extensive move by auto makers and their suppliers toward lightweight materials for pickup trucks and sport-utility vehicles to help them meet coming fuel economy standards, rather than push consumers into buying mostly small cars... Auto makers plan a broad shift to aluminum from steel in larger vehicles over the next decade in North America, and 18% of all vehicles will have all-aluminum bodies by 2025, compared with less than 1% now, according to an industry study released this week” (Ramsey June 11, 1014).

4.4-Issues of Political Economy

A milieu embedded by concrete-based transport artifacts has shaped the growth of a bureaucracy that locks people into a restricted range of choices over the manner in which they conduct their practical lives. The array of choices available to *some* people appears to have grown, but the critical question is this: does an increase in available choices within a narrowly prescribed sphere of existence represent an expansion of freedom? One of the effects of the transport sector is the production of “needs” brandished as expanded choice. “The range of choice open to the individual is not the decisive factor in determining the degree of human freedom, but *what* can be chosen and what *is* chosen by the individual” (Marcuse, 1964, 7). The association of automobile ownership with increased freedom conceals a political economy that enables the intrusion of businesses and government into the lives of individuals. The opportunity costs of car ownership from both an individual and communal standpoint require a closer look.

While freedom enables us to make choices, it does not necessarily follow that a greater array of choices leads to more freedom. On the contrary, increased buying options masquerade as freedom of choice when in reality they impose monetary and other burdens on people. Equating the expansion of consumer choice with freedom trivializes more profound conceptualizations of freedom that associate it with human agency and the choices related to the development of a person’s creative capacities. Reducing freedom to a burgeoning array of consumer choices (e.g. automobile style and color) corrupts the concept significantly. A wider array of automobiles and insurance providers to choose from does not expand one’s capacity to choose a particular path of development and growth. Rather than enabling persons to be the subjects of their own destinies, automobile dependency quite literally compels people, including non-drivers, to conform to the Iron Cage.

A landscape configured by massive road networks leads to a political economy that reduces public agency, unjustly distributes the cost burden onto the most vulnerable segments of the population, including nonhumans, and curtails freedom even as it seemingly provides an extraordinary array of choices for those poised to take advantage of them. Safe-driving subjects—constituted as such by insurance and regulatory bureaucracies through data collection and statistical normalization—interiorize the rules of the road. As a noteworthy illustration of operational biopower, these driving subjects police themselves, all the while attributing extended

freedom and autonomy to the very artifact (the car) to which they yield aspects of their agency (Patterson 2007).

Movement is governed and constrained by the spatial and temporal configuration of the road network. Both those who drive and those who do not must conform to the warp and weft of this vast network. Construction of the driving subject impacts the non-driving population who also must interiorize the rules of the road if they are to navigate the complex system of roads and avoid dangerous encounters with vehicular traffic. Those on foot or bicycle must often give way to vehicles, while intersections and traffic lights contribute to the temporal ordering of lives through timed stops and street crossings.

This association of the car with freedom conceals the consequences of the invasive bureaucracy and the impositional consumption that automobile dependency has spawned in its wake (Patterson, 2007). “People who associate freedom with automobile ownership miss the reality that the majority of individuals cannot choose *not* to buy a car” (Balabanian, 2006, 22). Of course the impacts vary from region to region, and from person to person. In some societies that have reached massive or pervasive motorization, the opportunity costs for society are reflected in high death toll from accidents and the appropriation of land to road construction purposes.

The transport sector has a homogenizing effect not only on the landscape but also on its inhabitants. Roads, highways, and runways fragment habitats, cutting off symbiotic lifelines for many species. People must comport themselves to the sector’s banalizing reconfiguration of the landscape, much of which results in inequities of access that make the lives of those without power and resources difficult to navigate. Transport systems dependent on massive concrete-and-steel edifices consume excessive hectares of the commons and make unreasonable demands on people by imposing a particular lifestyle on them, a lifestyle based on values they may not necessarily espouse. People compelled to own automobiles, particularly those with few resources, have no choice as to whether or how they will use the technology. On the contrary, its use as well as the particular lifestyle mandated by its use has already been predetermined by others (Balabanian, 2006).

The opportunity costs of owning and operating automobiles are borne not solely by car owners but also by non-car-owning members of the community. In some cities, e.g. Dhaka,⁴⁴ Calcutta, or Karachi, the mobility of those without vehicles is significantly inhibited and their lives are put at great risk as they attempt to navigate the city. Furthermore, even for those who own cars, ownership represents a choice only for some of them while others experience it as an imposition of the milieu. In parts of the U.S. in particular, the spatial arrangement of businesses, clinics, grocery stores, etc. makes owning and operating an automobile an absolute necessity. This urban sprawl forms spatial configurations that impose the burden of car ownership on many who cannot afford it and on others who would prefer alternate means of travel if they had the choice.

While vehicle ownership and operation may expand options for some, many low-income families find themselves in a double bind that prevents them from gaining socio-economic leverage. On the one hand, they are unable to afford the rents or mortgages in areas accessible to public transport and to other services such as the workplace, schools, clinics, grocery stores, etc. On the other hand, living in remote areas where the rents and mortgages are cheaper but where public transport services are scant or non-existent means such persons have no choice but to expend significant portions of their income in automobile ownership and maintenance. Even a family that plans wisely, living frugally in order to put away a savings, faces the tragic situation of being forced to watch their savings consumed in car ownership and maintenance.

People in these unfortunate circumstances face a tragic no-win situation: they cannot get to work, to the clinic, or the grocery store without a car, and yet they must work in order to afford the car that will take them to work, the clinic, and the grocery store. The benefits biofuels are intended to confer will not be felt by these members of society. On the contrary, should the Jevons' paradox materialize, these persons will bear an unfair share of the consequent societal burdens.

A milieu imbricated by auto-centric artifacts privileges auto transport over other forms by transforming the horizon of possible alternatives. Once such a complex system becomes part of the landscape and is viewed as “the way things are,” alternative structures that could distribute the benefits of mobility more equitably while uprooting less of the landscape appear more

⁴⁴ (piece on Dhaka from The New Republic)

unrealistic as they recede into the realm of the ideal-but-unthinkable. Within such a milieu, many of those able to own/operate vehicles gain significant leverage in terms of mobility, employment options, healthcare alternatives, schools, etc. Meanwhile the same milieu exacerbates existing inequities by exacting financial and practical life burdens on disadvantaged persons to whom an auto-centric transport sector can seem burdensome rather than facilitating. Furthermore, the tax codes in some regions translate into a situation in which low-income taxpayers end up disproportionately financing transport infrastructure that primarily benefits the better-off. While the system of tolls in some regions distributes the cost more equitably, this does not change the fact that those who neither own nor operate vehicles cannot access this land.

Through allocation of public lands to highway construction, the public is cheated of land held in common, yet they continue to pay taxes to support it. Those who do not own/drive vehicles cannot access land surface allocated to highways and road networks. With worldwide expansion of concrete jungles, less and less of the commons is available. The taxes that citizens in some regions pay to maintain road infrastructure are regulated by tax codes that do not differentiate between those who own/operate vehicles and those who do not. This creates an unjust system, with tax revenues utilized for a road infrastructure that excludes many of the very persons who finance it.

In some regions of the world the expansion of concrete jungles to accommodate auto/air transport disrupts lives by leading to social dislocation and the destruction of livelihoods. The conversion of forests, rivers, streams, etc. to superhighways and/or runways not only results in social dislocation and the loss of livelihood for some but makes this transformed land cover accessible only to the privileged minority able to drive and fly. This injustice is felt particularly keenly by indigenous groups in regions of the world (e.g., China, India) that, for many generations, have relied on forests, rivers, lakes, etc. for basic subsistence. The injustice is intensified by the fact that many such communities have established elaborate supportive social networks that forced displacements tear asunder.

The massive suburbanization that characterizes much of the U.S. landscape and increasingly other regional areas has created a situation advantageous to some while many others find it burdensome: "... the interstate has combined with the growth of suburban population and suburban employment to enable the development of a new kind of American metropolis that is

access-efficient for the vast majority of American *households that own an automobile* [my italics], but increasingly difficult to navigate for those who do not” (Jones, 2008, 133).

4.5 Concluding Reflections

I have highlighted the frameworks (assumptions) that shape the construction of maps how these play out in terms of material impacts. In this case, I have pointed out that the biofuels thought collective produces knowledge (constructs maps) framed by the existing auto-centric transport sector, a framework that foregrounds growing automobile demand as a presumed necessity while backgrounding or concealing alternatives. I have also shown that this framework is itself informed by the progress narrative, a culturally embedded narrative that permeates mainstream energy and environmental discourses at large.

Important to realize is that the need for biofuels has arisen, at least in part, from the issues discussed here. While it is not an objective of the biofuels thought collective to incentivize governments, corporations, and people to embrace better, more equitable forms of transport, perhaps it should be. Indeed, if the problem definition was expanded to encompass the structural issues that lie at the root of the insatiable demand for fuel, one of the primary goals of the biofuels thought collective—development of a cleaner *cost-competitive* fuel source—would have to be reconsidered. After all, recent history with fuel price fluctuations strongly suggests that providing a competitively-priced fuel—with the added psychological incentive (a “green” fuel)—could actually stimulate an increase in VMT and air miles flown. This effect would play out in a growing demand for cars, planes, and the concrete jungles to support them.

Tragically, trends indicate that the expansion of concrete jungles worldwide shows no signs of abating, and this situation is not receiving the urgent attention it warrants. We are living at a time in which this kind of massive transformation of the landscape cannot continue unabated without dire consequences to the earth and its inhabitants. The tools available today make it possible to subdue the earth and assimilate it to human purposes on a grander scale than ever before, thus lending a particular urgency to the situation. The sudden expansion of concrete jungles and automobile manufacture on massive scales and in quite short timeframes played a role in bringing certain events to a critical-mass state.

The automobile has served as a significant cultural icon for numerous decades in the U.S., and fascination with the car exists and is growing in many other regions of the world. Warranting further study is the fact that the growth in popularity of the automobile worldwide is symptomatic of the export of a particular system of values that cannot be reduced to mobility requirements. As long as the psychological link between progress and extensive motorization remains unbroken, arresting the insatiable demand for automobiles stands little chance of succeeding.

The extensively mediated structure of modern societies combined with the continual development of new technologies place people at a further remove from other life forms on which they depend. Such distancing deludes the modern denizen into assuming that they can continue to thrive as a species in a significantly impoverished habitat. And this leads dangerously to the assumption that our species can continue in practices destructive to the milieu without having to suffer the worst of the consequences since a solution will always be waiting in the wings. When significant segments of material reality recede from view, we are no longer emotionally invested in those aspects of reality. The connection is broken, the emotional investment disappears, and we experience a dangerous clinical detachment.

Chapter 5: Ground Truthing III - Problematizing the (Energy) Consumption Ethos

In the introductory chapter, I pointed out that discourses do not operate autonomously but rather they operate within and on socio-technological regimes. Encompassing institutions, socio-economic and political interests, artifacts, discourses, and the relationships between these, the energy sector can be thought of as one such regime. Together with the transport and agricultural regimes, the energy regime exercises a tremendous enabling and constraining influence on the discourses that function within it. Likewise, the discourses shape the regime, enabling and constraining it in various ways.

Mainstream discourses perpetuate the momentum that contributes to path dependency and regime lock-in. To a significant degree, the knowledge production that takes place within mainstream energy discourse regulates or prescribes which knowledge claims qualify as acceptable within the biofuels thought collective. Counter discourses, depending on their capacity to generate contrary momentum, have the potential to destabilize regime path dependencies. Unquestioned narratives—e.g. the progress narrative, science/technology as the ultimate panacea—operate implicitly within the regime, informing the discourse that shapes the regime. The narrative that defines ‘progress’ as a linear march forward into continual societal betterment has a tenacious hold on the psyche.

In bringing to light the limitations inherent in practitioner maps, ground truthing can provide clues into the assumptions that inform the construction of the maps. Perhaps no single assumption has more influence on all mainstream energy discourses than the consumption ethos. I use ethos in its most expansive sense as a *Gestaltic* term that encompasses “the practices and habits, assumptions, problems, values, and hopes of a community’s lifestyle” (Keck 1974:440). The phrase “(energy) consumption ethos” in the title conveys the idea that all human consumption requires the expenditure of energy. Thus, to critique consumption is tantamount to critiquing *energy* consumption and vice versa.

Perhaps no other aspect of the broader energy discourse has more influence on the biofuels thought collective than the presumed necessity of growing energy demand, itself closely linked with belief that economic growth has no limits. Recall that in previous chapters I provide

repeated instances of the treatment of growing energy demand as the *independent variable* that drives all other considerations. Within the biofuels thought collective, the sense of urgency centers on satiating this demand rather than interrogating its premises. Yet leaving the consumption ethos unproblematized leads to impoverished problem definitions.

The drive to universalize the consumption ethos that dominates much of Western society runs up against these obstacles: the decline of accessible reserves of cheap, abundant energy and the arrival of the “age of extreme energy” in which every additional barrel of fossil fuel obtained requires increasing investments of energy and water as well as unacceptable levels of ecological degradation. Consumption as practiced in modern societies would never have been possible without a relatively cheap and readily-available supply of energy. The two industrial revolutions and the current digital revolution would have been inconceivable without this cheap and abundant supply of energy. Indeed, one of the obstacles to a wholesale replacement of fossil fuel sources with renewable sources is that these alternative sources would not be adequate to support economies that rely on extensive information communication technologies (ICTs) and resource-intensive transport infrastructures.⁴⁵ Often lost in the discussions about renewables is their diffuse nature compared to the sheer density of fossil fuels. Yet many energy practitioners simply assume that new developments in science and technology will make up for the inherent deficiencies of renewables. Now that a global economy operating according to a limitless growth paradigm is reaching natural limits, there are no limits to the scientific/technological solutions proposed within mainstream discourses. Yet not a single one of these addresses the root causes behind a grossly overextended human presence.

Because the debate is framed by an unexamined (energy) consumption ethos, the problem is reduced simply to a matter of developing and supplying a clean, reliable energy source. All efforts are then directed to making this happen, and that means investing considerable resources into scientific/technological interventions. Meanwhile, the ways in which the prevailing energy infrastructure is implicated in the society it is meant to serve (and conversely, the way society is implicated in the infrastructure) are left unexamined. The propensity for Westerners to view progress solely in terms of economic growth decreases the likelihood that energy practitioners of the mainstream discourse will highlight energy consumption as a problem worthy of special

⁴⁵ (Info/stats from article “The monster footprint of digital technology”)

attention. Indeed, for practitioners to do this would be tantamount to committing occupational and/or political suicide. Furthermore, it would bring into question the assumption that people across the globe, irrespective of vast cultural differences, would desire nothing more than to self-identify as consumers. Thus the problem of energy supply/demand is reduced to finding and developing energy sources and technologies that result in as little ecological harm as possible while enabling corporations to sustain and maintain profitability.⁴⁶

Economic growth, driven by consumption, cannot be decoupled from energy consumption. All manner of economic growth be it in goods or services involves investments and expenditures of energy. Hence expansion of the world economy is, by default, expansion of energy consumption, and all energy generation results in some kind of negative environmental impact, whether the initial energy investment is derived from fossil or renewable sources (Huesemann, 2006). Practitioners of mainstream renewable energy discourses, biofuels and otherwise, speak to the urgency of insatiable energy demand even as they treat such demand as an independent variable to which we are obligated to march in lockstep. In the following citation from some renowned biofuels practitioners, note the implicit characterization of civilization as a sort of juggernaut, that leaves us with little choice but to be carried along by its unstoppable momentum:

We can no longer afford the dangers that our dependence on petroleum poses for our national security, our economic security or our environmental security. *Yet civilization is not about to stop moving* [my italics], and so we must invent a new way to power the world's transportation fleet (Huber, Dale, 2009:52).

Another likely explanation for the reluctance of practitioners to suggest that conspicuous consumption practices are hugely problematic is that to do so would mean butting heads with corporations and with a large proportion of the public. Many of the institutional platforms that facilitate knowledge production are either allied with corporations and/or depend on corporate sponsorship, e.g., government agencies, academia, think tanks. Practitioners who venture to suggest that this ethos works against the best interests of society risk being marginalized.

⁴⁶ The idea that a project should be economically sustainable is generally reduced to that of sustaining or enhancing corporate profitability, often at the expense of communities and their sustaining habitats. Sustainability discourse is based on the premise that ecological, social, and economic sustainability can be held in tension, yet what so often materializes is that economic interests (defined as corporate profitability) contradict social and ecological concerns. Indeed, the entire sustainability enterprise brings into relief the difficulty of reconciling social and commercial values.

5.1 Energy Demand / Consumption: What Do the Statistics Say?

When we take a close look at the statistics on current and projected energy demand, what is the story they tell? Advances in energy efficiencies notwithstanding, aggregate energy demand continues to grow and is projected to grow quite significantly into the next few decades (citations). But what does this really mean? The figures and statistics I highlight in the following paragraphs play a critical role in the characterization of the (energy) consumption ethos. They have considerable persuasive power in that they associate notions of progress and prosperity with high levels of (energy) consumption. Perhaps most interestingly, the figures ‘tell’ more by what they conceal than by what they reveal.

Recent statistics compiled by the International Energy Agency (IEA), the Energy Information Administration of the U.S. Department of Energy, and the International Panel on Climate Change (IPCC) indicate a steady growth in global aggregate energy demand over the next few decades. Estimates project a 56 percent increase in world energy consumption between 2010 and 2040 (US-IEA, 2013). Of course, responsibility for this growth is not evenly distributed, with some regions contributing a larger share than others. Generally, the steepest increases are projected to occur in the non-OECD (Organization for Economic Cooperation and Development) countries such as China and India, with more modest but still significant increases in OECD nations such as the U.S. and Western European nations. The outlook on the fossil fuel / renewables mix is not very promising, with “fossil fuels [projected to supply] almost 80 percent of world energy use through 2040” (US-IEA, 2013:1). The observation by the International Energy Agency that the U.S. “is projected to become the largest global oil producer (overtaking Saudi Arabia until the mid-2020s [...])”, has come to pass as of this writing (IEA, 2013:1).

Growth in population is clearly a factor in the growth of energy demand and must be reckoned with. Yet the mainstream discourse frequently correlates increases in energy demand to population growth without factoring in other variables that significantly complicate this one-to-one correlation. When analyzing the impact of population growth on energy demand, increasing global per capita consumption must be factored into the analysis. Growth in consumption can be attributed in part to the efforts of emerging economies (China, India, various regions in South America and Africa) to attain the affluence prevalent in highly developed nations (Hone, Schmitz, 2004; International Energy Agency, 2012).

Also compounding population growth as a factor in energy demand increases is the energy consumption stimulated by improvements in efficiencies in various sectors. To put it succinctly, population needs to be addressed as a problem of consumption rather than a problem of sheer numbers. After all, energy availability drives consumption which stimulates population growth. Another source of growing energy consumption generally not considered by the mainstream is the frenetic pace of world trade brought on through a combination of various trade treaties (e.g. NAFTA) and World Trade Organization (WTO) policies (Klein 2014).

The global aggregate projections show steady growth through 2050. While efficiency gains in the OECD nations reflect some leveling off of demand, the combination of higher consumption stimulated by those gains and the steep rise in demand for automobiles, and other accoutrements of modernization in the emerging economies indicates that efficiency gains alone will not curb demand (International Energy Agency, 2012). While true that innovations have brought about significant improvements in energy efficiency—“Today’s appliances require less than half the energy they did four decades ago” (Guevara-Stone, Oct 15, 2012)—increases in consumption coupled with the rapid growth of emerging economies are stimulating overall increases in aggregate demand. And, while energy-efficiency improvements in some arenas have indeed curbed consumption, promoting efficiency gains as a silver-bullet resolution takes the onus off of corporations and individuals to engage in less socio-ecologically harmful consumption practices. Indeed, efficiency innovations all too easily turn into a convenient pretext for conducting “business as usual” (BAU) while avoiding the far more difficult business of revisiting and reevaluating values.

Missed in the showcasing of efficiency gains is that many devices promoted for their energy efficiency actually *embody* significant amounts of energy required in their production. Thus, the triumphalism surrounding innovations in energy efficiency conceals the energy invested in all of the processes involved in product production, distribution, and disposal.⁴⁷ Such black-boxed energy is particularly pertinent to digital technologies for which up to 80 percent of the energy consumed occurs in the mining and processing of components that go into the product’s manufacture.

⁴⁷ (data/info from article: “The Monster Footprint of Digital Technology”)

Claims regarding energy use must always be evaluated within the context of the claim. How are the claims framed? Are per capita energy-consumption figures presented in conjunction with aggregate figures? And what does each of these statistics tend to conceal? This is no trivial matter since the way in which these figures are presented can lead to incorrect conclusions about the true state of affairs. Simply comparing the aggregate energy-demand statistics for China and the U.S. (which is often done) creates the misleading impression of the Chinese citizenry as particularly aggressive in its consumption, with the U.S. citizenry relatively more moderate. However, including per capita figures alongside the aggregate figures adds complexity, leaving a rather different impression of the situation. On the one hand, China's larger aggregate consumption reflects the efforts of an emerging economy with a very large population to fast-track the modernization process, while the per capita figures highlight the fact that Chinese citizens consume on average significantly less than U.S. citizens.

However, even these statistics tell only part of the story. Per capita normalization conceals the fact that energy consumption is not evenly distributed throughout the population. It distributes the 'blame' equally across the population when often the most affluent members of a society, through exercising their greater consumption capacity, tend to consume much more energy than the poorer segments of society. For example, the Energy Information Administration statistics portray the United Arab Emirates (UAE) as having by far the highest per capita energy consumption—798.3 million Btu/person—in the world. Yet this figure is likely distorted by a few significant outliers whose consumption is many times more than the poorer members of the general population.

If framed strictly in terms of energy-efficiency improvements in a single region, say the U.S., without contextualizing the figures in terms of the other world regions, we are left with an overly sanguine picture of the U.S. and an unjustly dismal view of emerging economies. For example, U.S. per capita energy consumption shows a decrease from 339.3 million Btu/person in 2005 down to 312.8 million Btu/person in 2011 (Energy Information Administration, n.d.) and an increase in China from 52.3 million Btu/person up to 82 million Btu during the same interval. These figures clearly indicate that the U.S. per capita consumption continues to exceed the rate in China by a significant degree. The decrease in per capita use in U.S. is generally attributed to

increases in energy efficiencies, not to deliberate decisions on the part of corporations and individuals to draw down their consumption.⁴⁸

Depending on how these normalized figures were arrived at, they probably do not reflect changes in demographics that impact energy consumption. For example, an interval spanning from the 1970s to the present in the U.S. would likely indicate a significant decrease in per capita energy consumption. However, attributing the decrease solely to efficiency gains does not take into account the impoverishment in basic living conditions that has impacted significant segments of the U.S. population during this interval. Indeed, the scenario may be much more complex than the efficiency-gains assumption warrants.

Concerns about greenhouse gas emissions have reframed the debate, directing increasing worldwide attention toward renewables. Yet there are few signs that practitioners of mainstream energy discourse plan to utilize the opportunity to revisit the fundamental ethos of which ecological degradation and ‘extreme’ oil are symptomatic. Note in the following citation how growing energy demand is mystified, suggesting that the most critical challenge at hand is to find ways to satiate it while inflicting less ecological harm:

One central issue facing policymakers and electric utilities is the question of how to meet the rapidly growing worldwide demand for electricity while not increasing global greenhouse gas emissions. The U.S. Department of Energy’s Energy Information Administration [...] projects a 75% increase in global electricity use between 2000 and 2050. By 2050 tripling of use is probable. (Holton, 2005:A743).

The effect of such statements is to reduce the notion of ecological sustainability to a form of “damage control.” In other words, the suggested protocol is “business as usual” while inflicting as little damage as possible.

A significant proportion of GHG emissions (approximately one-third) is generated from electricity production. This situation has opened a window of opportunity for the nuclear industry to reframe the debate in such a way as to promote nuclear power as a clean, renewable energy source (Scientific American Board of Editors 2011; Scoblic 2008). The renewed enthusiasm for nuclear power that some regions are witnessing illustrates the way in which symptoms tend to overshadow root causes, serving as ‘red herrings’ that distract from the real issues. In the rush to embrace an energy source visually disassociated from the dirty

⁴⁸ Of course, the U.S. decrease could be explained in part by the 2008 economic crisis, although there are indications that dampers on fuel consumption were short lived. Once oil prices began to stabilize beginning in 2009, vehicle and air miles traveled returned rather quickly to their pre-2008 levels.

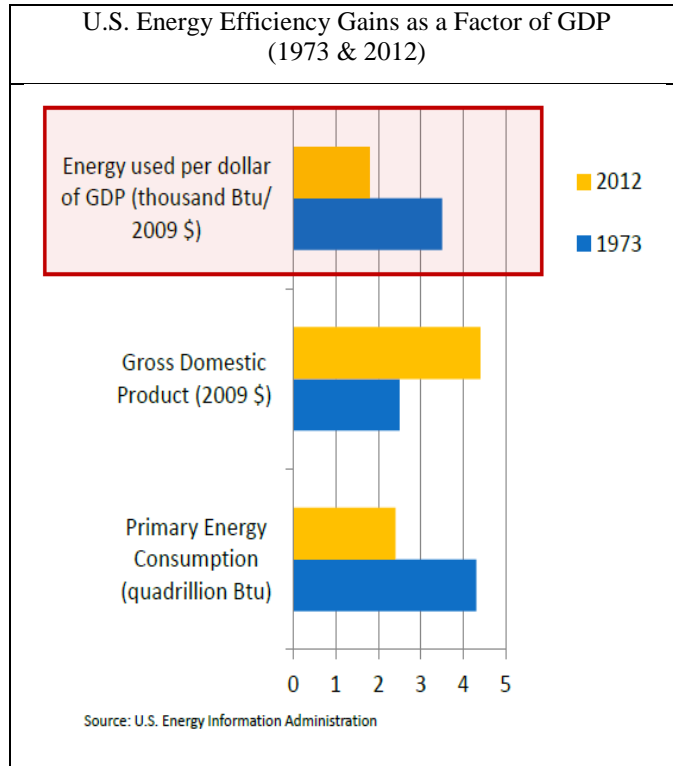
smokestacks of coal-fired plants, critical discussions regarding the ecological implications of uranium mining and radioactive waste storage/disposal are addressed separately. Instead, these significant issues are treated as though tangential to electricity production. Yet others promote nuclear as an interim solution until less controversial energy sources are fully developed. But they underestimate the forces that would work against dismantling this complex infrastructure and replacing it with something more benign.⁴⁹

5.2 Are Efficiency Gains a Pretext for Consumption?

Gains in energy efficiency through technological innovation are often promoted as the solution to lowering energy consumption. Economists utilize a figure called economic energy intensity (EEI) to determine the efficiency of a nation's economy. The EEI number "reflects the ratio between megajoules (MJ) of energy consumed by the economy (the biophysical input calculated in energy terms) and the GDP produced by the economy (the resulting economic output, calculated in terms of added value measured in a given currency referred to a given year)" (Polimeni, Mayumi, 2008). Table 5.2.1 (below) depicts a clear gain in U.S. economic energy efficiency (EEI) in 2012 when compared with that of 1973. Despite a significant increase in GDP during the interval, the amount of energy required to produce each dollar of GDP experienced a significant decrease. In 1973 approximately 3,500 Btu were required to produce one dollar of GDP whereas in 2012, the number of Btu required decreased to approximately 1,800 Btu per one dollar of GDP. This represents a nearly 50% gain in energy efficiency.

⁴⁹ This phenomenon is sometimes referred to as the "Collingridge Dilemma." At the beginning of a project before anything is "set in stone," it is easy to envision multiplicity of alternatives because nothing has yet been established. The dilemma at this stage is that nobody can anticipate the outcome of any particular alternative in advance. The second dilemma occurs after a particular trajectory has been chosen (nuclear power for instance) and the supporting infrastructure and bureaucracy are well established, thereby making it extremely difficult to envision alternatives that do not fit into the existing system. This is similar to the phenomenon Ronald Wright (2004) describes as the "progress trap"...the idea being that, particularly in the case of complex systems, when the needs of society point in a new direction, it becomes difficult if not outright impossible to change direction.

Table 5.2.1 Energy Efficiency Gains as a Factor of GDP



Source: Annual Energy Outlook, 2012

Used with permission of the Energy Information Administration of the U.S. Department of Energy, 2015

Yet the situation is not quite as simple as it appears. The chart oversimplifies (as such charts are wont to do) a complex situation by presenting only one side of the story. As I discuss in a subsequent section GDP figures are problematic because they conceal the true costs of production. Yet such charts serve a powerfully persuasive function because the simplistic picture they convey is utilized by politicians and policymakers to promote unmitigated economic growth. However, concealed by these statistics is that energy efficiency gains may actually spur increased activity, thus negating the gains achieved through technological developments.

Recall the Jevons Paradox⁵⁰ introduced in chapter four that demonstrates how efficiency gains can lead to increases rather decreases in consumption (Alcott, 2005; Huesemann, 2006:

⁵⁰ The Jevons paradox (or rebound effect) pertains not just directly to fuel/energy consumption, but to resources in general. Indeed, the digital revolution is exemplary in this regard. One of the most common materializations of the paradox is the use of paper. York (2006) describes the “paperless office” paradox in which he demonstrates that the advent of the PC and email not

Polimeni, Mayumi, et al., 2008: Sorrell, 2010; York, 2006). For instance, Jevons demonstrated that once significant economies had been achieved in the smelting of iron, this reduced the cost of iron which thereby stimulated the use of iron in many new areas for which it had previously been far too costly. Indeed, between the years 1830 and 1863 “*the reduction of the consumption of coal, per ton of iron, to less than one-third its former amount, was followed, in Scotland, by a tenfold total consumption [...]*” (Jevons, 2001 [1865]:103).

Although per-unit-iron coal consumption decreased quite significantly, the effect was to boost aggregate consumption. And this does not include the “indirect effect of cheap iron in accelerating other coal-consuming branches of industry” (103). Jevons went on to point out that efficiency gains in one industry among several related industries will eventually spread to others. An input or process that becomes cheaper creates opportunities for the manufacture of new products that previously may have been cost-prohibitive to produce (Alcott 2005). Applied today to products that utilize silicon chips, the multiplier effect of efficiencies spreading to related industries would surely be difficult to assess because of the sheer number of industries involved. Because so many products rely on silicon chips, efficiency gains in this area have a rippling effect in countless other industries, even spawning new industries altogether.

Automobile fuel economies stimulated by the CAFE (Corporate Average Fuel Economy) regulations are perhaps the best contemporary illustration of the materialization of the Jevons paradox. Richard York (2006) draws attention to the way the improvement in vehicle fuel economy led to an increase in the number of vehicle miles traveled (VMT) as well as to an increase in the number of vehicles on the road. With improved fuel economy, drivers pay less to fill their tanks, leaving them with additional disposable income which many utilize to travel more. As I have pointed out previously, the number of vehicles per 1000 persons continues to rise dramatically in many regions of the world with the U.S. taking the lead (Jones 2006: McCarthy 2007).

Improvements in car design, making them lighter-weight and therefore more fuel efficient also led to a growth in bigger, heavier vehicles such as light-duty trucks and sports utility vehicles (York 2006). Just imagine combining improved fuel economy with cleaner,

only did not lead to a paperless office as originally anticipated, but has instead spawned a significant increase in the generation of paper documents. In classic Latourian fashion, the actants—ubiquitous printers and PCs—‘acted’ on the actors (PC users) by creating a situation that leads to a perverse incentive to print more rather than less.

reasonably priced biofuels. This scenario would combine increased efficiency with a replacement fuel that provides a moral pretext for driving/flying more miles. Biofuels ‘done right’ cannot consist in the mere replacement of one source of fuel with another. It would not be long before excessive demand for the fuel would lead to many of the problems outlined in the previous two chapters.

The Green Revolution demonstrates a sort of double Jevons paradox. On the one hand, the industrial agricultural practices that spurred the Green Revolution were possible only on account of the availability of a cheap, reliable energy supply (due to a combination of energy efficiency gains and available oil reserves). On the other, the economies of scale attained in food production led to a situation that actually aggravated rather than alleviated world hunger:

The Jevons Paradox seems to be true not only with regard to demand for coal and other fossil energy resources but also with regard to demand for resources in general. Doubling the efficiency of food production per hectare over the last 50 years (the Green Revolution) did not solve the problem of hunger. Unfortunately, this doubling of efficiency actually made the food shortage problem worse, since it increased the number of people requiring food, the fraction of animal products in the diet and the absolute number of the malnourished (Giampietro, 1994)” (Polimeni, Mayumi, et al., 2009:87).

The jury is still out on just how to draw the connection between efficiency gains in one sector leading to new applications and uses in other sectors (Alcott 2005). Yet, ample evidence suggests that the rush to implement efficiency gains without examining the consumption ethos that fuels many scientific/technological innovations is leading to undesirable consequences. Indeed, during the interval spanning 1950 to 2005, the U.S. economy experienced a doubling in efficiency (i.e. the energy consumed per unit of GDP) “which had the effect of increasing the aggregate consumption of commercial energy in the US economy by almost three times!” (Polimeni, Mayumi, et al., 2009:84).

Purchasing a newer version of a product because the newer one will conserve energy conceals the fact that these products require significant investments of energy in their production and post-utilization disposal. Furthermore, the ecological degradation from extraction of raw materials and the use of significant amounts of water in their processing should, at a minimum, give pause to those who promote energy-efficiency innovations as the solution to hyper-consumption of energy and the ecological degradation resulting from it. When one considers just a single product, the PC, significant efficiency gains realized during the PC’s utilization are negated by: a) the amount of energy embedded within the product (80% of the energy expended

for a PC occurs during the manufacturing phase), and b) the planned obsolescence that has led to a significantly shortened use duration as people purchase the latest model and ‘retire’ the ‘old’ one. Suffice it to say that many of these products consist of materials (e.g. plastic) that contain petroleum, and biofuels practitioners envision a bioproducts industry in which petroleum-based products will be replaced by bio-based products.

An energy theory of value would, similarly to Marx’s labor theory of value,⁵¹ draw attention to the black-boxed energy consumed during raw material extraction up through marketplace sale. And I would add to this the energy required to dispose of the products when they become obsolete and/or no longer function. Whether they undergo a recycling process, are shipped overseas to nations paid to accept them, or simply dumped at a local landfill, all of these activities require energy investments. Thus while the newest computers, cell phones, etc. may be far more energy efficient in their use, the planned-obsolescence strategies that guarantee ‘markets’ for continuous corporate gain lead to situations in which people dispose prematurely of products that still have significant utility. Because the products are prematurely disposed of, the benefits of energy savings during utilization are negated by the much more significant amount of energy utilized in the device’s manufacture and recycling/disposal. Since all of these energy expenditures are externalized, the price paid by corporations and individuals for these items does not come close to reflecting their actual cost.

5.3 (Energy) Consumption: Signifier of National Prosperity

The belief in economic growth as the engine of progress has achieved significant hegemonic depth and extent in many regions of the globe. Symptomatic of this widespread belief is the discourse on education circulated by the leadership in many nations. This discourse is permeated by admonitions regarding the critical necessity of adequately preparing the respective nation’s workforce to compete in the global marketplace. Indeed, the recent U.S. obsession with STEM preparedness coupled with an

⁵¹ Marx critiqued capitalism for its failure to account for the embedded labor contained in the finished products sold on the market. For instance, the labor value of the cell phone includes the labor to mine and process the materials, the labor embedded in the extraction and processing machinery, the labor involved in the assembly of the phone, and the labor embedded in the tools and machines utilized in the assembly process.

alarming denigration of the liberal arts and humanities is symptomatic of a society dominated by the belief that ‘if you are not growing, then you are not prosperous’.

Economists interpret the gross domestic product (GDP) figures as a measure of a nation’s prosperity. In doing so, they reduce the notion of prosperity to only those activities in which money exchanges hands. This means of course that the GDP figure renders invisible any activity in which money does not exchange hands, regardless of how much that activity may contribute to the wellbeing of a society.⁵² This includes all those priceless entities on which no monetary value can be placed:

GDP only includes services that are legally bought and sold. It does not include components of the environment such as wilderness areas or native birds that are not bought and sold. Keeping trees in a forest is not counted in GDP, and is not counted as contributing anything towards a nation’s wellbeing; but when a tree is cut down and sold as timber it adds to GDP and therefore to economic growth (Beder, 2010:127)

A yet more perverse result of this rendering is that activities and products that are ecologically destructive (e.g. fracking, coal mining) are credited to GDP because they generate revenue for the businesses involved. Abetting this perverseness even further: reclaiming and restoration of land and/or ecosystems damaged by such activities are also credited to GDP, again, because corporations involved in the cleanup record gains. For example, “the year that the ship *Exxon Valdez* spilt its cargo of oil in Alaska, that state’s GDP rose dramatically because of all the money spent trying to clean up the spill” (Beder, 2006:128).

Rising energy demand is viewed as an indicator of a nation’s growth and prosperity. Particularly where emerging economies are concerned, it is correlated with changes in the standard of living: “Generally speaking, the higher a country’s standard of living, the more energy it consumes” (Fachagentur Nachwachsende Rohstoffe, 2009:4). Problematic with statements such as this is that their authors assume that “standard of living” is a static concept whose meaning all understand and agree upon. The fact that different cultures view living standards quite differently does not even enter into the discussion. Such sentiments are often expressed by those situated in affluent Western states who presume to be speaking for all other peoples and nations.

⁵² Thus, even the shuffling of paper that takes place upon a corporate merger or takeover shows up in the GDP figures as income, although nothing concrete is produced by the transaction. On the flip side of the coin, significant amounts of productive work that contribute to society, much of it undertaken by women, never makes it into the GDP figures for the simple reason that no money exchanges hands.

As long as high levels of energy consumption are associated with what the mainstream discourse deems as a high standard of living, interrogations of consumption practices are unlikely to arise or be taken seriously. Indeed, the alleviation of poverty is often coupled with the increasing (energy) consumption associated with a particular conception of a ‘high’ standard of living. And that same standard is assumed to be embraced by all irrespective of region and culture. In the following citation from a 2004 report of the World Business Council for Sustainable Development (WBCSD) addressing energy and climate change, the authors associate the alleviation of poverty with economic growth—defined as increased (energy) consumption:

In 2000, only one in six of us on this planet had access to the energy required to provide us with the high living standards enjoyed in developed countries. Yet these one billion people consumed over 50% of the world’s energy supply. By contrast, the one billion poorest people used only 4%. None of us finds poverty acceptable, so the world has set itself various goals to eradicate poverty and raise living standards. These goals require energy, *the driver of modern living standards* [my italics]. Increased access to modern energy services such as electricity is a decisive factor in escaping the poverty trap; it vastly enhances *opportunities for industrial development* [my italics] and improves health and education (Hone, Schmitz, 2004:2)

Disregarded by the above claim is that this “driver” (energy) that made modern conceptions of the ‘good life’ possible for a minority of the world’s population has already peaked and is now on the depletion side of the oil/gas reserves curve. Renewable resources are unlikely to ever have the capacity to sustain such levels of modernization on a universal scale. The previous citation also seems to imply that the remaining five out of the “one in six of us on this planet” aspire to the ‘standard of living’ as defined by a privileged minority. Many who make such claims reduce the quality of life to a matter of how much ‘stuff’ one can purchase, consume, and dispose of over the course of a lifetime. While many in modernized societies equate quality of life with purchasing power, there are many people whose quality-of-life values cannot be reduced to amassing more goods, “many of them bogus innovations that are of no appreciable benefit to our lives” (Boudrillard 1998:40).

Growing evidence from several fronts suggests that the conspicuous consumption that characterizes this high standard of living available to the “one-in-six” cannot be universalized without risking complete collapse of the biosphere:

Consider, for example, the ecological footprint—the average amount of productive land and shallow sea appropriated by each person for food, water, housing, energy, transportation, commerce, and waste absorption—is around 1 ha (2.5 acres) in developing nations, but about 9.6 ha (24 acres) in the United States (Wilson, 2002). If every person in the world enjoyed the same level of material consumption as in the United States, three to four additional planets would be required, and even more (up to 12) if future population and economic growth is taken into account

(Rees and Wackernagel, 1995; Wilson, 2002). Not even the present world population...let alone the 10 billion expected by 2040 can hope to achieve North America's material standard of living without destroying the ecosphere and precipitating their own collapse (pp. 89 and 90) (Huesemann, 2006:565).

Economic discourse regarding measures of a nation's health has permeated the public realm, achieving significant hegemonic depth and extent. The GDP concept, despite its problematic assumptions, continues to be embraced as the primary means by which a nation's prosperity is assessed. Many non-OPEC emerging economies are fast-tracking their development in an effort to 'catch up' to the hyper-modernized nations in the OPEC club. No nation's leaders, after all, relish the prospect of being a "zero-growth" nation. A GDP that reflects zero growth stigmatizes those nations to which it applies. Conversely, high GDP figures represent a nation as prosperous even as they conceal growing poverty, inequality, and ecological degradation. On the other hand, low and/or decreasing GDP figures may conceal prosperity. In the nation of Bhutan, success in transitioning to non-export, subsistence farming, and livelihoods directed toward contributing to the local community translated to a drop in GDP. By all mainstream accounts, Bhutan is not prospering, yet other indicators show that the people of Bhutan are more satisfied on average than denizens of highly modernized societies.⁵³

Confusing the issue further still is that the utilization of per capita GDP figures to compare the standard of living across nations renders invisible the inequities in distribution of costs and benefits of all the activities in a nation in which money exchanges hands. High GDP figures are misleading because they hide the gross inequities of distribution of costs and benefits that exist in reality. Thus, the relatively higher per capita GDP of the U.S. compared with other nations renders invisible large segments of the U.S. population who have little or no access to livelihood. Equally problematic in this regard is that the figure conceals the fact that many persons bear disproportionately the brunt of environmental disasters, the remedying of which is reflected as a positive sign of growth in the GDP statistics.

Reducing a nation's progress and well-being to a statistical figure not only conceals the costs to society of conspicuous consumption but in many instances treats those costs as benefits. Indeed, many industries are spawned by the ill effects arising from progress so-called, a phenomenon described by Jean Baudrillard (1998) as the "homeopathic treatment of growth by

⁵³ Vandana Shiva lecture, "The Lunacy of Economic Growth," at Jenseits des Wachstums, Berlin, Germany

growth.” As such, he indicts the measures of economic growth that, magically it seems, transform the symptoms of societal malaise into indicators of prosperity:

The advances of affluence—that is to say, of the possession of ever more goods and individual and collective amenities—have been accompanied by increasingly serious ‘environmental nuisances’ which are a consequence, on the one hand, of industrial development and technical progress, and, on the other, of the very structures of consumption. First, we have seen the degradation of our shared living space by economic activities: noise, air and water pollution, environmental destruction, the disruption of residential zones by the development of new amenities (airports, motorways, etc.). Traffic congestion produces a colossal deficit in technical, psychological and human terms. Yet what does this matter, since the necessary excess of infrastructural building, the extra expenditure on petrol, the costs of treatment for accident victims, etc. will all be totted up as consumption, i.e., will become, under cover of the gross domestic product and statistics, an indication of growth and wealth! (Baudrillard, 1998:39).

Because material consumption is the means by which a society can attain well-being and “GDP is merely a measure of that means [...] the goal of economic development should not be to maximize GDP but to improve human well-being and quality of life” (Sorrell, 2002:1794).

The perversity of assessing a community’s well-being in terms of its material consumption becomes clear when the logic of doing so is followed to its own absurd conclusion: communities who deliberately choose to cut back on their consumption cannot prosper. And on the other side of the ‘perversity coin’ the logic reaches this conclusion: the more a society spoils its own living space (and that of communities beyond its borders) through conspicuous consumption, the more prosperous it is.

The belief that GDP statistics are reliable indicators of progress conceals the very decline and degradation that makes such ‘progress’ possible. The irreversible destruction of millions of hectares of Canadian boreal forests in order to extract oil sands primes the GDP figure because it generates cash flows. The struggle of indigenous activists to preserve these uniquely rich forests becomes a Sisyphean task within the context of a system in which GDP growth is correlated with the ongoing destruction of the forests.

An accounting system based on fundamentally problematic notions of progress also manifests itself in the traditional rendition of assets. The system values as assets the goods produced from natural organisms but not the organisms themselves. In a classic instantiation of Aesop’s fable about the goose that lays golden eggs, such systems of valuation encourage the assimilation of the very organisms (the egg-laying goose) into the modernization project, thereby destroying the characteristics (the capacity to lay golden eggs) for which they were valued in the first place:

The difference in the treatment of natural resources and other tangible assets provides false signals to both economists and politicians. It reinforces a false dichotomy between the economy and the environment that leads them to ignore or destroy the latter in the name of development. *It confuses the depletion of valuable assets with the generation of income* [my italics]. And it promotes and validates the idea that rapid economic growth can be achieved and sustained by exploiting the resource base (Repetto, 1989:40).

5.4 “Insatiable” Energy Demand as a Presumed Necessity

In its 2012 report entitled *World Energy Outlook*, the IEA laments the fact that “the world is still failing to put the global energy system onto a more sustainable path” and lists several persistent trends: “energy demand and CO² emissions rise ever higher; energy market dynamics are increasingly determined by emerging economies; fossil fuels remain the dominant energy sources; and providing universal energy access to the world’s poor continues to be an elusive goal” (IEA, 2012). Yet throughout the report, the rise in energy demand as an issue in itself requiring attention, never enters into the discussion. Indeed, changing energy demand is always framed within the context of modifying or redesigning consumer products, (e.g. cars, computers) to be more efficient. And the lament about failing to provide universal access to the poor is framed by the assumption that if we could just get the ‘right’ technology in place, inequitable access and distribution issues would simply disappear.

The latest findings of the International Panel on Climate Change (IPCC) seem to confirm the fact that we have entered an age in which the impact of the human presence on the earth is so significant that other life forms are finding it increasingly difficult to meet their own survival needs. Interestingly, another report from the same group (IPCC), this one aimed at renewable energy sources, points to the rise in global energy demand, all the while treating it as though it were an immutable fact of our existence:

Demand for energy and associated services, to meet social and economic development and improve human welfare and health, is increasing. All societies require energy services to meet basic human needs (e.g. lighting, cooking, space comfort, mobility and communication) and to serve productive processes” (IPCC, 2011:7).

While not to deny that basic human needs must certainly be met, the reference to “economic development” seems to indicate that continued economic growth, even in fully modernized nations is not only necessary but inevitable. The statement is misleading because it implies that most of the increase in energy demand is due to underserved populations gaining access to basic services. Not mentioned is the attainment of middle class status by millions

across the globe or the relentless pace of hyper-modernization that continues unabated even in fully ‘modernized’ nations. The digital revolution, spreading like a wildfire, demands the sacrifice of yet more ecosystems to the expansion of information communication technologies (ICTs). The planet, already stretched to capacity, cannot sustain extensive global information networks. Despite numerous claims regarding the efficiency and sustainability of ICTs, their manufacture “black boxes” significant levels of energy consumption and ecological degradation.⁵⁴ Furthermore, the trend of many modernization or ‘betterment’ endeavors dislocates vulnerable populations. The modernization of Harlem, a ‘gentrification’ project initiated by former New York City Mayor Bloomberg, stands as a striking example of such a trend.

After pointing out the problems associated with GHG emissions, the report goes on to state, “There are multiple options for lowering GHG emissions from the energy system *while still satisfying the global demand for energy services* [my italics]” (7). Note that *satisfying demand* rather than *reducing demand* is at the heart of this statement. The statement is framed by ‘free-market’ ideology which is premised on unfettered growth and consumption. I suspect that some scientists at the IPCC believe that capitalism is at the root of these issues, yet within the mainstream discourse, capitalism is the “pink elephant” in the middle of the room that everybody sees but nobody dares publicly acknowledge as it would be tantamount to professional suicide. Also implicit within the statement is that science and technology will be quite capable of addressing the environmental issues resulting from current levels of energy consumption even as that consumption continues to increase. Given the tenor of such statements, it is difficult not to conclude that the notion of sustainability is merely an afterthought, a form of “damage control” relied upon to mitigate the worst outcomes.

In another statement linking the needs of the poor with rising energy demand, a U.S. politician implicitly lays the ‘blame’ on the rising poor and fails to mention the conspicuous

⁵⁴ A word of caution is in order here: It is assumed by many that ‘virtual’ highways are less dirty, obtrusive, and invasiveness than concrete and steel. As yet another illustration of the power of language to shape reality, words like ‘wireless’ or ‘virtual’ have entered the lexicon, subtly persuading people to believe that in fact digital technologies come without all the obtrusive accoutrements we associate with mechanical devices. But appearances are deceiving. Black-boxed by these technologies is the entropy (disorder) that results from their production. A cell phone is a tiny island of order that exists amidst a vast sea of disorder—degraded mined landscapes, toxic mine tailings, vast amounts of waste water, high-density (i.e. high-order) energies (e.g. coal) dissipated as emissions (i.e. low-order) during the silicon-chip manufacturing process, etc., etc.

consumption that characterizes his own nation: “We live in a world of growing demand for energy as billions of people are rising out of poverty. As that demand for energy grows, it will require new energy production capacity” (Bingaman, 2008:33). He then makes a sweeping generalization that reduces complex socio-economic and ecological issues to a sheer matter of technology, all the while treating energy demand as a presumed necessity: “Reengineering the way the world produces, stores, distributes, and uses energy may in fact be the greatest challenge that we as a global community must face together” (38).

Mainstream renewable energy discourse operates on the assumption that renewable resources can, by virtue of their status as natural components of the biosphere, support both existing and growing demand with very little ecological damage. Not considered by this assumption is the *scale of the interventions* that would be necessary to harness and/or extract these flows, processes, and entities of the biosphere. Certainly the harnessing and redirecting of the sun and the wind is less harmful than removing mountain tops and degrading millions of gallons of water to extract fossil sources. Because increases in scale always change the character of the problem, we cannot know with any certainty the consequences that may follow from an extensively scaled-up implementation of renewables.⁵⁵

Human interventions for producing energy operate according to the laws of thermodynamics, meaning that some kind of waste always results (Ayers, 1998; Huesemann, 2003;2006; Huesemann & Huesemann, 2011). The First Law of Thermodynamics, framed from an environmental perspective states that “all resources extracted from the environment must eventually become unwanted wastes and pollutants. This means among other things that ‘externalities’ (market failures) associated with production and consumption of materials are actually pervasive [...]” (Ayres, 1998:190).

The Second Law of Thermodynamics⁵⁶, also called the Entropy Law states that “all industrial and economic activities have unavoidable negative environmental consequences”

⁵⁵ A noteworthy example of a simple solution for keeping homes cool during the hot weather and therefore lowering energy consumed by air conditioning is to paint the roof of the house white. Some communities have adopted this practice in part to counter the effects of global warming. This simple solution may be harmless implemented at small scales. However, if a densely populated nation were to adopt this practice enmasse, there is no telling what the outcome may be.

⁵⁶ Viewed from the Second-Law perspective, human industrial enterprises are attempts to create islands of order (neg-entropy). An artifact such as a cellphone is an island of order that when produced creates disorder (entropy) elsewhere. For example, the microchips utilized in cellphones are produced from mined materials and the production process utilizes many gallons of water that ends up as waste water at the end of the process. The mines are islands of order that produce disorder or entropy (e.g. through massive land change and toxic mine tailings). Waste water treatment plants are islands of order (neg-entropy) that

(Huesemann, 2003:21), or stated another way, “the Second Law of Thermodynamics maintains that chaos or disorder (entropy) within closed systems must increase with time” (Huesemann & Huesemann, 2011:17). From this perspective, utilizing renewables as energy inputs involves the use of highly ordered (i.e. low entropy) dissipative structures that, through industrial/production processes, get transformed into low-order (i.e. high entropy) substances (e.g. waste, pollution). In sum, “diversion of solar energy to human-related subsystems result in entropy increase in the environment” (Huesemann, 2003:26).

Due to the tight coupling of economic growth and energy consumption, there are clear limits to economic growth. Industrial ecologists seek to improve the materials cycle by developing ways to deal with the waste resulting from materials transformation, e.g., recycling, applications and uses for byproducts, etc. However, recycling itself requires energy inputs and produces its own waste. The laws of thermodynamics make it impossible to completely close the materials cycle such that no byproducts or waste result. Only ecosystems have this capacity. Excessive consumption is already running aground on the laws of thermodynamics and tragically, the entropy resulting from a superfluity of ‘islands of order’ (i.e. neg-entropy) in modernized regions is not localized to those regions. Much of what we witness today is the result of several centuries’ worth of industrialization involving the transformation of low-entropy fossilized solar energy into high-entropy pollutants. Poorer regions often suffer a disproportionate share of the impacts, although the brunt of the responsibility rests with highly developed societies.

At a minimum, “it must be realized that the capture and conversion of solar energy will have significant negative environmental impacts, especially if they are employed on such a large scale as to supply nearly 100% of the U.S. energy demand” (Huesemann, 2003:25). Note here that Huesemann’s assessment pertains only to U.S. demand. Included in this calculus is the embedded energy contained in the artifacts (e.g. solar panels, photovoltaic cells, windmills, dams, harvesting equipment) and processes required to harness and/or extract solar energy.

attempt to recover order from disorder (i.e., the waste water). However, as the materials cycle cannot be completely closed, this island of order also produces islands of disorder (entropy) elsewhere, e.g., the solid waste left over after the filtering process. At a significantly smaller scale of consumption than is prevalent in highly-developed nations, this would not be a problem. However, under existing scales of production in which numerous ‘islands of order’ (i.e. artifacts) are produced, the resulting islands of entropy (disorder, waste, pollution) created by an ever-burgeoning consumer industry will reach critical mass and bring about significant irreversible ecological damage (entropy). A not-insignificant factor in all this: an economy based solely on renewables, should this ever be attainable, will be starting from a biosphere already suffering irreversible impacts of conspicuous consumption conducted under a regime of highly toxic non-renewable fossil fuels.

Thus, production and implementation of these artifacts on large scales creates its own degradation even apart from their use in converting energy to usable forms.⁵⁷

5.5 Costly Fuels Masquerading ‘On the Cheap’

Despite the protestations that the U.S. needs to cure its “addiction to oil,” simply replacing one fuel source with another will not resolve the factors leading to that addiction. The price at which corporations and citizens obtain liquid fuels and electricity plays a significant role in perpetuating fossil fuel dependence in many regions. Although the price may vary considerably by region, in many regions it does not accurately reflect the costs involved in the extraction, processing, and transportation of fuel and electrical power. Nowhere is this more evident than in the U.S. where citizens and corporations pay very little for fuel and electricity.

Real costs frequently get hidden by significant taxpayer subsidization of the petroleum and nuclear industries (Carpenter, 2013; Myers, Kent; 2001; Overland, 2010; United Nations Environmental Programme, 2008). The emphasis on producing second-generation biofuels that will be competitive with fossil fuels on the marketplace assumes that such a marketplace actually exists. However, in reality, existing energy markets are an artifact of heavy subsidization. As reported by the International Energy Agency:

Subsidies to fossil fuels continue to distort energy markets and expanded considerably last year despite international efforts at reform. Global fossil-fuel consumption subsidies totaled \$523 billion in 2011, almost 30% higher than in 2010. The increase reflects higher international energy prices and *rising consumption of subsidized fuels* [my italics]. The subsidy bill would have been even more expensive without reform efforts in several countries. Financial support to renewable energy, by comparison, amounted to \$88 billion in 2011 (IEA, 2012).

Not only do subsidies bolster existing markets, but they often lead to the creation of markets that may not otherwise exist. Perhaps most problematically, they hinder the development of healthier alternatives. While renewables receive subsidies, many of these would not be necessary were the subsidies for fossil fuels and nuclear to be dramatically cut back and/or removed altogether. While some subsidies are necessary, particularly for insuring that the poor

⁵⁷ Solar panels for example utilize silicon chips and the manufacture of these chips requires mined materials, disproportionate amounts of water, and significant energy inputs. Likewise, energy crops cultivated to harness sunlight require energy- and water-intensive agricultural inputs. Dams can negatively impact certain fish species. Additionally, they interrupt river and tributary stream hydrology, leading to the backup and accumulation of sediments in the reservoir critical to microscopic life forms that live further downstream. Large dams in particular are known to stimulate seismic activity leading in some cases to earthquakes (e.g. in China and India).

have access for basic needs, many of the subsidies in place today are outdated, leftovers from a bygone era. As a case in point, in the U.S. “depletion allowances were introduced to promote oil production during World War I” (Myers, Kent, 2001:65), and despite the rationale for this tax subsidy having run out decades ago, the subsidy persists even today.

Persisting subsidies for fossil fuels increases the cost of transitioning to renewables since they will require subsidies in order to compete with fossil fuels, thus further distorting a market that is already largely an artifact of subsidization. By making fuel artificially cheap, the subsidies actually encourage excessive consumption. In many cases, ample energy supplies accessible ‘on the cheap’ encourage corporations, academic institutions, hospitals, and individuals to adopt practices that lead to the gratuitous consumption of energy. “The failure of governments to price energy properly means that consumption is higher, grows faster, and is more polluting than it should be, [with] fossil fuels and nuclear energy cost[ing] society many billions of dollars more than their users pay directly” (Myers, Kent, 2001:65).

One of the greatest challenges to full-scale commercialization of advanced biofuels is cost. The operating costs, particularly as regards the cellulose-to-sugar conversion process, are quite high. As such, biofuels produced from cellulosic feedstocks have thus far priced themselves out of the market since they cannot compete with the much lower price of fossil fuels. However, the goal of developing economically competitive biofuels is hardly reasonable within the context of a heavily-subsidized fossil fuel industry. Fossil fuel prices are artificially low since, with few exceptions (e.g. Germany), there are no attempts to insure that the real costs of oil extraction and fuel production get reflected in the price at the pump. Some of these costs are externalized environmental costs, i.e., ecological degradation resulting from extracting and/or processing. The firms that caused the damage are not liable for the costs of cleanup which are generally covered through tax revenues.

Because water is becoming an endangered resource worldwide, energy proposals must now treat water consumption as a significant criterion in gauging the viability of an energy project. In its 2012 report, *World Energy Outlook*, the International Energy Agency (IEA) states that “water needs for energy production are set to grow at twice the rate of energy demand” (7). Reflected in the projections for increases in water consumption are the “move toward more water-intensive power generation and expanding output of biofuels.” Although the IEA

assessment below acknowledges the sense of urgency created by the significant water resources required for fossil fuel extraction and processing, note that the threat to water per se is downplayed while the constraints posed by water depletion to various energy projects is highlighted. Biasing the report yet further is that the threat of contamination to groundwater and other water supplies posed by the extraction of tight oil/gas is not broached at all:

In some regions, water constraints are already affecting the reliability of existing operations and they will increasingly impose additional costs. In some cases, they could threaten the viability of projects. The vulnerability of the energy sector to water constraints is widely spread geographically, affecting, among others, shale gas development and power generation in parts of China and the United States, the operation of India's highly water-intensive fleet of power plants, Canadian oil sands production and the maintenance of oil-field pressures in Iraq. Managing the energy sector's water vulnerabilities will require *deployment of better technology* [my italics] and greater integration of energy and water policies (IEA, 2012:7).

Note the recurrence of the assumption that deploying better technology will adequately address the issue. Furthermore the energy demand proper that leads to excessive demand for water is not raised as *the* issue that requires addressing. Because practitioners treat increases in energy demand as the independent variable, they do not see that a problematic consumption ethos combined with global population growth is driving demand. And even those who may acknowledge it are constrained by the rules governing knowledge production to keep their concerns to themselves while they engage in the discourse as practitioners.

Coal mining, deepwater drilling, tar sands extraction, and fracking aptly illustrate how growing commercial demands tend to shape the development of bigger, more complex extraction technologies in terms of practices, processes, and artifacts. With time, both demand and technological capacity tend to co-shape each other. Continued growth in aggregate energy demand coupled with pressure to transition the economy to renewable sources may spur the development of extractive practices, processes, and artifacts that result in the pillaging of forests and fields just as mining has led to significant irrecoverable damage to the living spaces in many regions. Removing forest and/or agricultural residue for biofuels constitutes a form of extraction and it can result in the loss of the nutrient restorative function that such byproducts often serve. Even in the case of those byproducts such as forest biomass that would not require complex extractive technologies, full commercialization may shape the development of technologies to increase the efficiency of extraction, e.g., corn harvesters that simultaneously harvest the fruit and extract the stover.

The Jevons paradox has materialized within the petroleum extraction industry. Efficiency gains in extraction technologies and manufacturing processes are making it possible to extract oil from regions and/or geological formations that only a short time ago were considered far too risky and costly. Yet this extreme extraction comes at great cost, both ecologically and economically. The growing rush to garner unconventional sources of oil and gas through fracking and tar sands oil extraction, are leading to massive irreversible damage to land, soil, water tables, and forests. Regions where major gas shales are located are experiencing significant groundwater and food supply contamination (Heinberg 2013; Royte 2013). The extraction practices utilized in fracking involve injecting thousands of chemicals into the earth. “Drilling and fracking a single well requires 2,000 truck trips” (Royte, 2013:14), and in the U.S., due to what some practitioners refer to as the “Halliburton Loop Hole,” these practices have proceeded largely unregulated:

Fracking a single well requires up to 7 million gallons of water, plus an additional 400,000 gallons of additives, including lubricants, biocides, scale and rust inhibitors, solvents, foaming and defoaming agents, emulsifiers and de-emulsifiers, stabilizers and breakers. About 70 percent of the liquid that goes down a borehole eventually comes up—now further tainted with such deep-earth compounds as sodium, chloride, bromide, arsenic, barium, uranium, radium and radon (Royte, 2012:13-14).

The energy return on investment is much lower than with conventional modes of extraction, meaning that the cost of obtaining this “tight oil” is much higher. An indirect economic cost is the impact of fracking on a nation’s road infrastructure, with the number of to-and-from truck trips necessary to accommodate the materials (water, chemicals) putting roads in some regions under great strain (Heinberg 2013). And obtaining tight oil and shale gas has ecological impacts that are felt immediately by all life forms within the vicinity of the fracking infrastructure and process.

If the price of fossil fuel were to adequately reflect true costs, including harm to the ecosystem, then the price would be quite high and would compel corporations, institutions, and citizens to make very different and difficult choices. Policies aimed at effecting changes across large segments of society cannot be effective unless the particular political instruments employed make it in the best interests of all members of the community to change attitudes and practices. Of course, utilizing monetary incentives to effect changes in behavior still does not address fundamental values. Yet strong financial incentives may facilitate a much-needed examination

of the relationship between government, corporations, and citizens, and a reconceptualization of corporate social responsibility.

5.6 Concluding Reflections

The groundtruthing analysis I have conducted in this chapter demonstrates how the discursive construction of maps is framed by dominant assumptions that comprise the (energy) consumption ethos. These assumptions permeate society at large and serve as regulatory mechanisms of mainstream energy discourses: 1 } the linking of progress with economic growth, itself reduced to the amount of money that exchanges hands; 2 } implementing the ‘right’ technology will produce benefits that will trickle-down, permeating society at large; 3 } Growing energy demand is an inevitable, immutable reality. Biofuels comprise one of a number of renewable energy resources undergoing intensive research, and as I have shown here, much of what emerges in the mainstream biofuels discourse is informed by energy discourse in general.

The linking of progress with economic growth regulates the discourse, making it next to impossible to problematize the key signifier of economic growth: energy demand. Since growing energy demand is an indicator of economic growth, it cannot be questioned. Hence, the maps of reality constructed by practitioners conceal this aspect of the terrain, creating a dissonance between what the maps represent and what actually exists on the ground. The belief that ongoing scientific/technological innovations can adequately address even the most complex issues leads to a situation in which practitioners focus on addressing symptoms rather than the structural issues that produce the symptoms. The discursive maps then end up occluding the full scale of the issue. While no map can possibly represent aspects of reality at actual scale, the framing of the problem as a technical issue by energy practitioners leads to the construction of maps that miss (or conceal) critical aspects of the terrain.

Citing Vannevar Bush who believed that science holds the key to societal problems, a U.S. politician echoes the views of many persons whose lives and livelihoods are unaffected by the exigencies of the socio-economic and ecological impacts of scientific/technological “progress” so-called: “Without scientific progress, no amount of achievement in other directions can ensure our health, prosperity, and security as a nation in the modern world” (cited in

Bingaman, 2008:38). Note the same politician framing the issue solely in technological terms, without so much as a nod to the pressing need to alter the structural issues that lead to conspicuous consumption, wanton waste of energy, and inequities of access and distribution:

Today's challenge is global rather than national. It is to change the way the world produces, stores, distributes, and uses energy so as to reduce greenhouse gas emissions. It is to shift, not just the U.S. economy but the global economy from dependence on combustion of fossil fuels to the use of non-emitting energy sources. With the concentration of greenhouse gases in the atmosphere on a trajectory to unacceptable levels, the sense of urgency to take action has risen as well. Simply stated [...] We must act and we must act now (Bingaman, 2008:33)

Also to be noted in the previous citation is the reduction of all energy-related issues to GHG emissions. Nothing is said about land, soil, or water degradation or the severe social injustices arising from highly-centralized energy systems. By this accounting, transitioning to hydro-electric power would be a positive step since it would lead, at least initially, to lowered GHG emissions. Debates in mainstream energy discourse do not generally deviate from the technological realm. In fact the statement "we must act now" from the previous citation can be read as a clarion call to address symptoms utilizing technological fixes. As I pointed out previously, addressing symptoms is important but tragically, vanishing symptoms tend to lead to an "out-of-sight-out-of-mind" perspective. Thus, instead of addressing the structural issues that brought on the symptoms, the rush is on the put out the next fire.

Many publications address issues about which renewable technologies are the most effective, most efficient, etc. Lost in these debates however are what may be the longer term implications of transitioning to renewables within the context of continued economic growth. Indeed, the discussions proceed as though transitioning to renewables is the means by which economic growth may be relentlessly pursued, albeit in a 'cleaner and greener' fashion. Yet in reality this is not possible because renewables are critical to the complex web of life of which they form a part, and we cannot intervene in this complexity heedless of any of the consequences likely to ensue. As in so many other cases addressed in the previous chapters, scale plays a critical role in determining the impact that any particular energy-producing enterprise may have:

Many of the potentially harnessable natural energy flows and stocks themselves play crucial roles in shaping environmental conditions: sunlight, wind, ocean heat, and the hydrologic cycle are the central ingredients of climate; and biomass is not merely a potential fuel for civilization but the actual fuel of the entire biosphere. Clearly, large enough interventions in these natural energy flows and stocks can have immediate and adverse effects on environmental services essential to human well-being (Holdren, et al., 1980:248)

I raise the above issue by way of illustrating that complex problems defined in technical terms do not—and furthermore, *cannot*—factor in certain critical variables. These variables often manifest as critical issues when technologically-focused solutions are implemented without interrogating structural issues. Additionally, the solutions have a normative impact on future possibilities by narrowing the scope of options to a particular trajectory of choices that have already been made and implemented. In other words, the vision of possibilities narrows, even as the vision of what should or must be done grows more compelling. Particularly in complex modern societies where people’s livelihoods are so deeply implicated by complex infrastructures, technologically-focused solutions can close off some alternatives altogether (Balabanian, 2006; Laird, 2003; Sorrell, 2010).

Chapter 6: Beyond “Trickle-Down (T)ec(h)onomics”: Toward Revisioning Energy Provision as Localized Democratic Praxis

“A better system will not automatically ensure a better life. In fact the opposite is true: only by creating a better life can a better system be developed.”

--- Vaclav Havel⁵⁸

“Fundamentally, the task is to articulate not just an alternative set of policy proposals, but an alternative worldview to rival the one at the heart of the ecological crisis—embedded in interdependence rather than hyperindividualism, reciprocity rather than dominance, and cooperation rather than hierarchy.”

--- Naomi Klein⁵⁹

6.1 Summary/Commentary on Findings

In this chapter I begin by summarizing the primary contributions of my study and the broader concerns that the study raises. I then provide a rough sketch of what I deem the essential ingredients to charting an alternative pathway to the existing trajectory. I conclude with an epilogue consisting of a summary of further questions that emerged from this study.

I was determined at the outset to think big, avoiding a narrowly focused analysis that does not speak to larger issues. I believe that scholarship should, wherever possible, extend beyond the immediacy of the topic at hand to broader societal issues. The value of kicking off my analysis inductively was that as themes and patterns emerged, so too did a variety of theoretical approaches for describing the discourse and its potential effects. In my particular approach, I risked what may be viewed by some as a heterodox use of certain theories and concepts. However I believe that theories and concepts, like texts, are neither transparent nor static. The application of a concept or theory to a particular situation or problem is a dynamic meaning-making process by which the theory or concept itself ‘participates’ in the process and is thereby changed. From the beginning stages of my project, I framed my analysis of the biofuels discourse with this larger question: *what does this discourse say about the dominant frameworks*

⁵⁸ Cited in: Wink, Walter, *Engaging the Powers*, p. 74;

⁵⁹ Cited in “A People’s Shock,” *The Nation*, Vol. 299, No. 14.

that shape the relationship between humans and non-human species and their living spaces? Stated differently, my analysis was informed throughout by my desire to gain insight into the implicit frameworks (and thereby values) informing practitioner research and policy analysis.

My analysis of one aspect of the energy sector revealed patterns that characterize mainstream energy discourse broadly speaking. Many of the assumptions that inform the biofuels thought collective adhere in mainstream energy discourses more generally. A collective's thought style is influenced by the "existing fund of knowledge" (Fleck 1979/1935)—i.e. the system of existing stabilized knowledge claims. Biofuels knowledge claims achieve mainstream status via links to "an established cognitive-technical network," through their "connect[ability] to already accepted ideas," and their "congruen[ce] with already accepted findings" (Hernstein Smith 2005:64). This "existing fund of knowledge" is shared by all mainstream energy discourses.

I summarize below emerging key attributes of the biofuels discourse that may also be attributed to other mainstream energy discourses (e.g. wind/solar, hydro-electric, fossil fuels, nuclear):

- These cultural narratives frame the governance of knowledge production and circulation: 1) progress is linear and depends on continual economic growth for its realization, and 2) science/technology working in tandem with 'free market logic'⁶⁰ can solve socio-economic issues (what I call "trickle-down" (t)ec(h)onomics").
- The discourse, far from occurring autonomously, "lives" in and thrives on socio-technological regimes, those large and complex systems made up of institutions, artifacts, people, and the relationships between all of these. The biofuels discourse exists in a feedback loop with at least three regimes—agriculture, transport, energy. All of these regimes coexist with each other, and the mainstream discourse perpetuates their momentum along existing trajectories.
- Practitioners treat growth in energy demand (and by implication, population growth and hyper-consumption practices) as a non-negotiable independent variable.
- Practitioners come to the table with a cognitive orientation significantly shaped by their *Lebensraum* (habitat or living space). A *Lebensraum* consisting of vast reaches of concrete jungles organizes experience, arranging "symbols in such a way as to encourage certain interpretations" (Green, Li 2011:1686). The constitution of these homogenized spaces suppresses richness and diversity, leading to the impoverishment of the maps constructed by a thought collective.

⁶⁰ The supposed 'free market' is itself an ideology that conceals the non-existence of anything in Western society that remotely resembles the space of free exchange envisioned by Adam Smith. Instead 'free market' means massive government subsidies to corporations in the form of loopholes that allow these firms to recklessly destroy the habitat at citizen expense, e.g. the "Halliburton loophole" allows oil companies to inject a toxic 'cocktail' of chemicals into the ground (fracking) without any obligation to report the specifics of the mix to the EPA. Also to be considered is the extensive infrastructure (roads, bridges, ports, etc.), disproportionately supported by low-income citizens, that enables corporations to carry out their daily business.

- Economic sustainability—defined (implicitly) as the capacity for corporations to realize uninterrupted gains—is privileged over ecological and social sustainability. This creates a situation in which everything must be retrofitted to a quantitative cost-benefit analysis: “Economics-based environmental policies give priority to economic efficiency above all else. Principles that cannot be quantified in monetary terms and that are not compatible with business priorities are ignored” (Beder 2006:276).
- The culture of expertise dominates all mainstream energy discourse. Its predominating thought style—scientization—privileges ‘value-free’⁶¹ reductionist methodology. This culture organizes knowledge production in such a way as to makes it nearly impossible for practical wisdom and alternative expertises to inform and shape the knowledge base.

As mentioned in the introduction, the scholarship on system momentum and how technologies are constructed and adopted does not address discourse as a significant factor in creating and maintaining momentum (Collingridge 1980; Pinch, Bijker 1987; Hughes 1987; Klein, Kleinman 2002). Yet my study demonstrates the power of discourse to generate momentum within a socio-technological regime and to shape which technologies will be adopted. In at least three regimes (energy, agriculture, transport), the mainstream discourse follows a well-established trajectory. In the energy sector, biofuels research and policy proposals treat economic growth and the energy demand (and by implication hyper-consumption practices and population growth) as untouchable independent variables. This translates to path-dependent business-as-usual (BAU) solutions that encourage rather than discourage increasing energy demand. The agricultural sector exhibits a well-worn high-yield-cash-crops trajectory, and biofuels stand poised to travel along this same pathway. And finally, biofuels-for-transport proposals emerging from the mainstream discourse will likely maintain a trajectory requiring the assimilation of millions of hectares of land into concrete jungles.

Perhaps most critically, mainstream energy discourses operate within the framework of a dominant narrative that associates progress and prosperity with economic growth. This narrative has the effect of reducing energy infrastructure discussions to a matter of keeping the economic growth engine running at full tilt. Practitioners do not question rising aggregate energy demand because this rise is commonly associated with economic growth. The key question that mainstream energy practitioners are taken up with is this: can a particular energy technology keep the growth engine running without destroying the habitat? Questions of sustainability

⁶¹ The term is used ironically here to emphasize the fact that claims by scientists to the contrary, scientific methodology is infiltrated by instrumental and exploitative values.

within the mainstream are usually centered on how much yield we can obtain from a resource without completely destroying it.

The potential of the thought collective's representations to alter entire habitats is perhaps the most worrisome feature of the discourse. It shows that language is neither transparent nor static. More than simply convenient designations, terms like "energy crops" can give rise to practices that suppress diversity in plant organisms. "Reality, life, the individual are richer in content than the forms that attempt to grasp them and do effectively grasp them in a social order" (Feenberg 2002:33). Eradicating the particularities of the plants that the 'universal' category "energy crops" cannot capture leads to a transformed species in which the attributes most valued by the energy enterprise predominate.

Ground-truthing was a valuable exercise not only in comparing practitioner maps with the reality on the ground but in describing the *effects* that the maps have on that reality. The exercise enabled me to distinguish those types of knowledge claims that carry the most weight within the thought collective. Practitioners construct maps that favor those aspects of reality deemed most relevant by the thought collective. Thus, ground truthing made it possible for me to sketch a penumbra of the way in which knowledge production is organized and regulated. It enabled me to sketch out the predominating thought style that determines the types of knowledge and methods that can be legitimately pursued. Ground-truthing also clarifies the role of discourse as a powerful perpetuator of the momentum that can lead a socio-technological regime into a condition of lock-in.

As the title of this chapter indicates, the "trickle-down" ideology actually takes two forms, both of them symbiotically bound together. The familiar trickle-down economics ideology promotes the idea that when corporations are turning healthy profits, these profits will trickle down into society, benefiting the middle and working classes. Tragically, this uncontested assumption continues to dominate socio-economic policy despite ample evidence of its failure. Its 'evil twin'— what I have coined "trickle-down technomics"—rests on the assumption that innovations in science and technology will automatically resolve fundamental societal issues.

These assumptions conceal the fact that merely possessing the scientific/technological know-how to resolve some of the world's most pressing problems (e.g. hunger, poverty) does not

lead to their resolution. On the contrary, such issues appear to be worsening despite (or perhaps because of) the technological solutions thrown at them. “Failures in this regard are problems of allocation—of politics and global economics, of culture and conflict—but not of production capacity” (Sarawitz 1996:141). Many practitioners proceed as though their innovations can “compensate for the unfortunate frailties of human nature” (141), though many of their proposals are likely to reinscribe already-existing failures of political economy and ecology. Not only do the social issues *not* disappear, they often manifest as new problems once the innovations have been rolled out. “If humanity is unable or unwilling to make wise use of existing technical knowledge—knowledge already sufficient to free the world from elemental human suffering—is there any reason to believe that new knowledge will succeed where old knowledge has failed?” (Sarawitz 1996:142).

Many emerging technologies are more flexible, adaptable, and increasingly unobtrusive, e.g., nanotechnologies. Yet precisely these features make it easier to embed the technologies into complex systems in ways that make it increasingly difficult to manage, much less plan for, unanticipated consequences. Indeed, the bio- and nanotechnologies on which the development of alternate fuel sources relies means that tracing consequences to their source will be significantly more challenging, if not outright impossible. As such, rushing into particular solutions because they provide quick relief by addressing proximate and palpable symptoms has more potential than ever before to magnify problems by adding layers of inscrutable complexity.

Biofuels/bioenergy are particularly important in this regard because numerous technologies are under development that will reconstitute plant organisms, enzymes, etc on a massive scale. Because of rising aggregate energy demand, this could have significant impacts on the larger ecosystem of which these organisms constitute a part. Never before have we been faced with the capacity to reconstitute so much of our living space in a very short period of time. How can we possibly anticipate the impacts of reprogramming the photosynthetic cycle of plants on a massive scale? All of these organisms are part of a greater whole, and reconstituting and reinserting them into their habitat may bring about system disequilibrium.

The practice of scientizing issues that follows from trickle-down ideology co-opts the problem definition by casting a net around the quantifiable variables. Scientization assimilates the problem into a domain of knowledge production restricted to a narrowly-defined group of

experts and a singular way of producing knowledge. Because energy supply, provision, and access are fundamentally socio-economic in nature, scientized framing impoverishes the problem definition. Those aspects of the issue that do not fit into the frame are either redefined to fit the frame, discounted altogether, or may not even make it onto practitioners' 'radar'.

Scientization conceals the fact that existing structures of society are implicated in scientific/technological 'advances'.⁶² The unaddressed structural issues, while seemingly disappearing along with the symptoms, are implicated in the solutions and are thus reinscribed into the fabric of the society.⁶³ Biofuels are exemplary in this regard since the independent variable—continued global economic growth—is implicated in the proposals. This means that short-term gains realized in lowered GHG emissions will eventually be nullified and new problems will emerge as pressure to increase crop yields leads to problematic agricultural practices. Below I have summarized distinctive features of scientized energy discourses that have emerged in this study:

- Complex societal problems are brought into the orbit of science/technology, thereby facilitating control of the process and the outcome by an elite cadre of experts even as groups with differing expertises are disenfranchised from critical participation in problem definition. Emerging in tandem with this problem is that the wisdom that emerges from lived experience is often dismissed as irrelevant and irrational.
- Oversimplification of problems leads in part to the misplaced faith in the capacity of science and technology to solve complex issues (Fleming 2007; Huesemann & Huesemann 2011), and a tendency on the part of government, corporations, and citizens to avoid difficult choices by allowing science and technology to stand in as convenient surrogates for social policy (Sarawitz 1996).
- The retreat into the technical realm by experts who (consciously or otherwise) attempt to deflect public criticism and/or eschew responsibility. This short-circuits a broader discussion of the values implicit in problem definitions and proposed solutions.

Existing mainstream discourse excludes those whose thought style differs from the dominant thought collective, a collective credentialed on the basis of a narrowly defined set of criteria. By naming the insiders 'experts' and charging these experts to speak on behalf of those

⁶² I use 'advances' ironically to make the point that much of what we claim to be 'advanced' does little more than add to the coffers of large corporations even as it degrades the habitat and leads to socio-economic injustices. Fracking, tar sands extraction, deep-water drilling, and megadams are fitting illustration of scientific/technological 'advances' that, while beneficial to a life style that only a minority of the world's population has access to, tend to foster decline rather than advance through severe ecological degradation, social dislocation for millions, and massive public subsidization of corporate profit borne disproportionately by low-income taxpayers.

⁶³ The following observation regarding expectations that the abortion pill RU-486 would revolutionize society resonates with the trickle-down technomics ideology: "It's the age-old hope that a single technological or scientific advance will once and for all resolve a social issue, a fantasy that means forgetting that the new thing will be embedded in the existing system and involve existing human beings" (Pollit 2014:15).

outside the collective, an elite minority of the population is given the privilege and power to shape the society according to their own unexamined values.⁶⁴

All too often, experts do not solicit the opinions of nonexpert “ordinary” people because in their world of sense, the culture has devalued all forms of knowing and doing that are not based on highly specialized scientific and technical knowledge” (Vanderburg 2005:219)

This culture of expertise excludes valuable wisdom born out of firsthand experience with structural issues that impose particular life-worlds. Furthermore, it sequesters the production of knowledge from real-world experience, creating a “spectator” perspective (Dewey 1916; Vanderburg 2012) that leaves important judgments and decisions to those least likely to be negatively impacted by prevailing structures.⁶⁵ The negotiation of knowledge amongst those who share the same thought style can lead to judgments that inadvertently place undue burdens on vulnerable human and nonhuman populations. Because the energy sector impacts every domain of existence, leaving the problem definition to a collective of highly specialized experts undemocratically enables a privileged few to shape the destinies of millions.

Perhaps nothing threatens the richness of our knowledge about the world more than large-scale extractive energy systems since it is precisely these systems that pose the greatest threat to indigenous groups. We will never be able to assess the magnitude of the losses resulting from the construction of the Three Gorges megadam in China, a World-Bank-approved project under which entire civilizations were buried. Not only were thousands of people dispossessed of the commons that provided their livelihood, but another casualty of this project was the place-based knowledge passed down over many generations. We have to only to witness the struggle of indigenous groups against tar sands removal in Alberta to realize what is at stake for people whose entire livelihood depends on fostering an intimate relationship to the land over many generations. *The devaluing of knowledge production that deviates from the scientific method makes it next to impossible for practitioners of the mainstream thought*

⁶⁴ Given the assumption by many experts that their research is “value-free,” it is not likely that values enter into the discussion.

⁶⁵ Vanderburg (2012) claims that this spectator or detached perspective leads to “visually-apprehended” knowledge production. He contrasts this with “dialectically-apprehended” knowledge production in which meaning-making takes place via a dialectic with lived experiences and culture. Dialectically-apprehended knowledge is locally situated whereas visually-apprehended knowledge is universal, making it possible to transfer technologies from one region to another without extensive adaptation. Dewey (1916) also contrasted meaning-making from a “spectator” standpoint with situated meaning-making that takes place through participation. “While the participant engages in ‘life activities,’ the spectator is unnaturally sequestered from those activities, which depend for meaning and form on the fact that ‘self and world are engaged with each other in a developing situation’” (Dewey 1916:148 cited in Wolf 2014).

collective to realize how the absence of these diverse knowledges impoverishes their own knowledge base.

As indicated in chapter five, the propensity for energy practitioners to treat energy demand as an independent variable is best understood within the context of the underlying (energy) consumption ethos. This ethos of excessive consumption—reinscribed by government policies, corporate bottom lines, and the practices of increasing numbers of people across the globe—is inextricably bound up with the progress narrative. This narrative is intimately bound up with those narratives that view the human conquest of nature (including those humans deemed ‘inferior’) as part of ‘man’s’ destiny and as having no bounds (Klein 2014). Despite both historical and present realities that contradict it—e.g., depleting reserves of cheap fossil fuels, irreversible ecological devastation, dangerously depleting water supplies—the narrative persists to the point of having achieved the status of a civil religion (Greer 2013). The particular potency of such narratives lies in their capacity to serve as an unacknowledged framework that shapes mainstream energy discourse. Indeed, what characterizes a discourse as *non-mainstream* or *counter-hegemonic* in this case is one whose practitioners problematize these powerful narratives.

Previously in this study, I discussed Heidegger’s comparison between Michelangelo’s chisel and a modern artisan wielding a laser by way of illustrating the sheer potential of modern technologies to shape and transform habitats. The sheer power of the modern “laser-wielding artisan” lends a particular urgency to interventions into the habitat, demonstrating clearly that *we are not simply doing more of the same*. The technologies available to us today not only make it easier to extend pillaging of the earth to remote areas of the globe, they enable us to significantly decrease the temporal scale at which changes to the biosphere are taking place. As one critical instance of this phenomenon, marine biologists have observed unusually rapid changes in oceanic biogeochemistry (brought about in large part by CO² emissions) that have historically been associated with geologic intervals.⁶⁶

We are habituated into a mindset that uncritically scales up innovations that prove to be effective at small scales, oblivious to the criticality of scale as a potent variable in its own right.

⁶⁶ Most disturbing for scientists studying ocean acidification is “the rapidity of today’s changes. The same shifts that took place over the course of a few thousand years during the PETM [Paleo-Eocene Thermal Maximum] are now due to happen over just a few centuries, counting and from the beginning of the Industrial Revolution and the widespread use of fossil fuels” (Renton 2014:12)

Innovations that enhance life in a small community, with scaling up, can imperceptibly metamorphose into an irreversible curse. This human propensity to get repeatedly caught up in the “progress trap” (Wright 2004) signifies an unwillingness to come to terms with our finitude. The “more-is-better” mentality has been the downfall of many cultures throughout history and continues to plague our own (Diamond 2005; Wright 2004). Despite a history strewn with the wreckage of our unwillingness to accept limits, the scale and pace of the digital revolution seem to indicate that we are headed right down the same treacherous path. Silicon chip technology, hailed as the harbinger of a new age of efficiency, is actually a “Trojan Horse” concealing a vast ‘army’ of water- and energy-consuming components.⁶⁷ “Contemporary cultures appear to have lost the capability of evolving their ways of life based on the recognition that everything depends on everything else” (Vanderburg 2005:219).

The problem of excessive (energy) consumption is becoming increasingly difficult to ignore within the context of critical thresholds of ecological degradation. The relentless perpetuation of new ‘markets’ to service an ever-growing array of ‘consumers’⁶⁸ shapes the thought style that regulates mainstream energy discourse. As such, practitioners invest significant effort into devising energy efficiency innovations that merely reinscribe the dominant images linking economic growth with prosperity. The books *Natural Capital* and *Reinventing Fire*, published by the Rocky Mountain Institute, exemplify this pattern. In the introductory chapter of *Natural Capital*—“The Next Industrial Revolution”—the authors invite readers to envision a glowing future where brilliant technological innovations already underway will all but eliminate climate change, poverty, social injustice, and unemployment.

The authors then ask, “Is this the vision of a utopia?” (1), and then respond by stating, “In fact, the changes described here could come about in the decades to come as the result of economic and technological trends already in place” (2). Perhaps most strikingly, these practitioners sidestep the issue of population growth and consumption practices, treating these as

⁶⁷ In a classic case of a modern-day Jevon’s paradox in operation, the efficiencies made possible by the miniaturization of silicon chip technology have stimulated new uses for the chip, to the point where this technology is being utilized for a vast array of goods, including automobiles. However, because silicon chip manufacture is extremely energy and water intensive, implanting these chips into solar panels could detract significantly from solar as an eco-friendly technology. Likewise, embedding silicon chips into automobile technology will neutralize efforts (e.g. electric cars) aimed at increasing the efficiency of utilization.

⁶⁸ I use ‘markets’ ironically by way of emphasizing their contrivance by corporate interests, i.e., these are anything but ‘free markets’ of exchange. Likewise I refer to ‘consumers’ ironically to highlight the fact that people become ‘consumers’ of products only after they embrace the false ‘needs’ that are constructed by corporations attempting to find venues for their latest products.

inevitable. Rather than expose the dominant frameworks that have led to a problematic human presence, they propose designing more efficient ways to assimilate nature into the growth economy:

In the next century, *as human population doubles* [my italics] and the resources available per person drop by one-half to three-fourths, a remarkable transformation of industry and commerce can occur. Through this transformation, society will be able to create a vital economy that uses radically less material and energy. This economy can free up resources, reduce taxes on personal income, increase per-capita spending on social ills (while simultaneously reducing those ills), and begin to restore the damaged environment of the earth. These necessary changes done properly can promote economic efficiency, ecological conservation, and social equity (Hawkin, Lovins, et al. 1999:2)

6.2 Toward Revisioning Energy Provision as Localized Democratic Praxis

Today's colossal energy bureaucracies were built up on a fuel base that offered a seemingly infinite and cheap resource, "cheap" only because our oversimplified accounting practices do not calculate externalities.⁶⁹ The bid to develop an increasing array of potential energy sources to continue to feed the production-consumption frenzy means that creative capacities are put to work in the service of a technics that prevents community members from shaping their own destiny (Mumford 1964). Communities end up surrendering their agency to complex juggernaut systems that impose particular life worlds onto them, often leaving vulnerable groups bearing inequitable cost burdens. The very energy infrastructure that makes present-day activity possible has been cut off from its "natural human and geographic limitations" (Mumford 1934:196 cited in Byrne, Toly et al. 2006:2), and has become completely insensitive to the needs of the community. Reconnecting with the needs of the community will require energy delivery systems significantly scaled back and designed for community ownership, oversight, and operation.

Urgently called for is a radical change in the way we conceptualize energy. Asking, 'how can energy demand be accommodated?' is the *wrong* question. "We have to assume that

⁶⁹ Externalities, in general terms, are the ecological and public health issues that arise from technologies and processes utilized by firms and institutions in the conduct of their daily operations. For example, a nuclear plant cooling process regularly cycles water from a local water system (river, lake, etc.) into and back out of the plant. The warmed water negatively impacts the lake, pond, and riverine ecosystems, yet this cost of doing business does not show up as an operating expense on the firm's general ledger. Such externalities do ultimately get 'paid' for, but often in the form of irreversible losses of life-sustaining ecosystems and/or in publicly-funded cleanup and restoration projects, borne disproportionately by low-income citizens. Of course, the irreversible degradation and/or irreplaceable species get 'expensed' over the course of future generations in a sort perverse 'amortization' of assets.

humanity's fundamental challenge is not how to *generate more* but how to *curtail demand* and consumption" (Orrego 2012:4). And of course, once we actually prize open the black box labeled "demand," we will find concealed inside population growth combined with perpetual cycles of production and consumption. I argue that energy provision, particularly for meeting basic needs, is *not* first-and-foremost a technical project but rather a *social* endeavor and must therefore be shaped by democratic praxis at the local community level.

The difficult question is this: How do we manage to come "unstuck" from the dominant frameworks that keep us locked into a destructive treadmill of pursuits that threaten our habitat. How might we break the stalemate of insanity that propels us along the same hackneyed trajectories? When something "works," we tend to unreflectingly assume the same thing will continue to "work" in all situations and in all contexts. This is particularly problematic with modern technologies due to their sheer capacity to transform entire regions. Such transformations are beginning to have an impact on the Earth's circulatory system, even impacting the composition of the atmosphere (Oreskes, Conway 2010).

We cannot find the answer by attacking the problems within the same framework by which we created them. The situation calls urgently for *revisiting*, *revising*, and *reconnecting*. In particular, two fundamental changes need to occur: a) a drastic reduction in the overextended human presence relative to other species, b) the revising of energy provision as a *social* issue that can be properly addressed only by involving local communities in the ownership and oversight of their own energy-delivery systems, and c) expanding the complexity of problem definitions by revisiting the dominant model for knowledge production and revising "expertise" to include alternative knowledges, particularly the practical wisdom of lived experience.

Perhaps a bit of metacognition is in order, i.e., stepping back and reflecting on the way we think. The way we think about ourselves, other species, the habitat, and our relationship to these lies at the heart of energy extraction practices that rape and pillage the earth. Hence, the only way to bring about meaningful and lasting change is to deconstruct existing mental models and construct new ones. All concrete proposals to 'fix' the interconnected crises of energy, ecology, and political economy that we face will end up stranded on the shores of the attitudes and assumptions that brought us to this juncture in the first place. As long as we hang on to

existing mental models or frameworks, rushing to the next technological ‘fix’ will only make matters worse.

Expanding our moral imagination is a challenging yet essential first step toward destabilizing the dominant economic growth framework. Patricia Werhane (1999) defines moral imagination as “the ability in particular circumstances to discover and evaluate possibilities not merely determined by that circumstance, or limited by its operative mental models, or merely framed by a set of rules or rule-governed concerns” (93). An expansive moral imagination encompasses the capacity see beyond the obvious: “To have a sense something is limited, one has to be able to see beyond its boundaries” (Downey 2010:390). While many brilliant design ideas continue to be researched, we repeatedly end up at the same handwringing place we started from because we continue to think and plan according to the same framework. Imagining new possibilities outside the mental models or scripts that dominate the situation requires disengaging from those mental models and understanding how they shape our approach to problems (Werhane 2002). Equally critical, it requires stark recognition of the limitations of the scientific method to address the systemic issues we face.

The provision of energy to a community provides a unique opportunity to strengthen localized democracy by empowering citizens to participate in policy and decisions that will shape their communities. The concrete nature of the issues around energy provision make it a well-suited ‘laboratory’ for expanding citizen participation and gradually eliminating large corporate interests altogether. Such localized, simplified systems are better poised to avoid the conditions leading to full-blown regimes that become ends in themselves (Mumford 1964).

Of course, the question then becomes, how do we build resilience into communities so that their members feel empowered to take back what rightfully belongs to the community? How do you instill a sense of ownership and empowerment in communities such that citizens take an active interest in the deliberation and decision-making process? Many citizens view government agencies and institutions as operating at a far remove from the everyday realities they encounter. Thus initiatives for change, if they are to be effective, must be localized at the community level such that they engender a sense of stewardship and empowerment amongst community members. From a social justice perspective, those who stand to experience the

impacts of energy policy the most palpably should have the final say in forming and adopting the policies best suited for their community.

Conceptions of private property must be revisited if we are to have any hope of changing the existing trajectory. “Private, unaccountable control of productive property prevents many people from participating in the shaping of their own and the community’s future” (Meeks 1989:57). Particularly in the U.S., the private concerns are not accountable to the public despite the fact that their business operations are facilitated by publicly-financed road and railway networks, runways, and shipping depots. The U.S. constitution, certainly in terms of Supreme Court interpretations rendered over the past 150-plus years, tends to favor the protection of private property over the common welfare (citations).

Critical to note within the current context of grassroots movements aimed at taking back the commons, “private” is derived from the Latin term *privare* which means to deprive. This original rendering of the concept speaks to the “widespread ancient view that property was first and foremost communal” (Capra 1982:197). In other words, private property was viewed as *depriving* the community of what it required in order to advance and protect its own welfare.⁷⁰ Within this context, energy-delivery systems owned and operated by private corporations disempower communities, depriving people of their capacity to look after the welfare of their own communities.

Practical changes that force a revisiting of the public/private partition are already underway in various regions. Some communities in Germany, for instance, have already begun the process of taking ownership of the energy delivery systems that service the local population (Klein 2014). There are some communities in the U.S. involved in struggles to redefine corporate accountability, in some cases forcing corporations to pack up and leave the community and/or preventing them from establishing business within the community’s precincts (citations). Vandana Shiva has been involved with communities in India that have waged struggles to deny corporate access (e.g. Coca Cola) to water sources that belong to the commons. Such endeavors demonstrate that we are not limited to a binary choice between privatization on the one hand and

⁷⁰ John Lock’s “atomistic theory of human society” (Capra 1982:197) shifted the mindset yet further away from the “communal, participatory viewpoint to more individualistic and self-assertive views” (195). With this shift in paradigm, “people no longer thought of private property as those goods that individuals *deprived* [my italics] the group from using, but actually inverted the meaning of the term, holding that property should be private in the first place and that society should not deprive the individual without due process of law” (195).

nationalization of industries on the other. Local ownership through a cooperative empowers community members, making them feel a sense of stewardship and responsibility.

Knowledge production and ‘ownership’ is yet another aspect of the problematic private/public divide. Certainly in the U.S., the majority of working citizens who pay taxes that finance research have no access to either the research or the fruits of that research. And the access issue cuts two ways: 1) the presentation of research in academic journals plays to a very small ‘gallery’ of like-minded persons, and 2) despite the public financing that makes these publications possible, most people cannot access the journals without a costly subscription.

The dominant system of knowledge production with its extensive specialization makes it difficult if not impossible to address problems of a systemic nature. The “splitting off of expert cultures from the everyday cultural practices of life”—what Jürgen Habermas describes as “the pathology of modernity” (Schüssler Fiorenza 1983:xxiii)—leads to hubristic assumptions regarding the capacity of science and technology to address all kinds of issues. The global dominance of the scientific method is assumed by many to be tantamount to its superiority over alternative ways of knowing and doing. That science “works” in many instances seems a logical extension of the premise that the scientific method has no equal for arriving at truths about our world.

Those who hold most tenaciously to this view generally belong to the minority of the world’s population that benefits the most from scientific/technological ‘advances’. Meanwhile, the costs of such ‘advances’ often go unacknowledged by the same privileged groups largely because such costs are externalized where they are borne disproportionately by the most disadvantaged segments (human and nonhuman) of the population. The global dominance of the scientific method cannot be considered apart from the dominant consumption ethos or the global commerce and degradation that are the very expressions of that ethos. Put another way, the colonization of centuries past continues unabated in the form of intellectual and material assimilation of the global “standing reserves” (humans, plants, ecosystems) made possible through scientific and technological ‘advances’.

There are at least two forms of alternative expertises that are discounted or ignored by the dominant culture of expertise yet which are *sine qua non* if we are to change the course of our present trajectory. There are the alternative experts who for many generations have been

habituated into a life that involves intimacy with a *Lebensraum* not extensively mediated by modernized structures. These expertises include indigenous groups and people living in modernized societies whose livelihoods require extensive knowledge of the surrounding habitat, e.g., Cumbrian sheep farmers.⁷¹ Then there is the practical wisdom that emerges from the everyday life experiences of modern denizens compelled to navigate extensively-built living spaces. The marginalizing of practical experienced-based wisdom combined with the apotheosis of science and the scientist is proving detrimental to community, democracy, and the very survival of the biosphere.

Previously, I introduced the concept of “circulatory scaffolding” as a means of describing how certain knowledge claims and the practitioners who propagate them acquire force and authority. The same scaffolding—institutions, practitioner credentials and prestige, publication venues, etc.—that gives mainstream claims force and authority also prevents alternative claims from gaining any force. Calling attention to this scaffolding would represent a significant step toward establishing a new framework for addressing energy needs and for adding complexity to problem definitions. Good scaffolding provides supporting structure without drawing attention to itself. Indeed, within the context of a theatre, scaffolding showcases the performance and the performers even as it recedes into the background. By foregrounding the existing scaffolding and drawing attention to the specifics of its supporting function, we can destabilize it. Only then will the opportunity emerge to revision and reconstruct the circulatory scaffolding in such a way that alternative knowledge claims will receive the force and authority they have been denied by the existing structure.

Another way to add complexity to problem definitions is to take steps toward integrating the academy back into the community. At the national level this would require acknowledging that the ties between academia and corporate interests have grown disconcertingly cozy and that steps must be taken to dissolve these interdependencies. Short of this, science and engineering research will continue to be constrained as well as compromised by corporate “bottom-line” interests. Another step would be to change publishing and tenure requirements to motivate

⁷¹ In Brian Wynn’s case study of the Cumbrian sheep farmers (1996), the soil chemists involved in the debate with the farmers missed a great opportunity to enhance their own science. The sheep farmers acquired knowledge through generations of implicit knowledge available only in a dialectically-apprehended world (Vanderburg 2012; Wynne 1992). A vigorous dialogue of meaning making and knowledge exchange would have benefited both the soil chemists and the farmers. In like manner, some of the situations we face would benefit from alternative ways of knowing.

scholars to move out of the ‘echo chamber’ of their own disciplinary discourse and out into the public square where they would be compelled to speak a different language in order to make their ideas understood by a broader audience. The idea would be to publish and present in a way that engages community members and encourages their feedback and responses.

It is high time to create an environment in which scholars are willing to serve as public intellectuals, provoking controversial discussions without any fear that the stands they take may amount to professional suicide. Additionally, academic institutions could establish a more active presence with the communities in which they reside. By this I mean establishing an academic structure that promotes the involvement of both students and faculty with the people who live in the surrounding community. Some universities are already involved in initiatives toward this end. California State University has been engaging in what is known as “Public Sphere Pedagogy” in which faculty design syllabi that facilitate the integrating of student projects with current issues that are well-known to community members. I have chosen to render this concept “Public Square Pedagogy,” replacing “sphere” with “square” because the former term problematically implies separate spheres: one for the public, and one for academia. Thus, “Public Square Pedagogy” more accurately connotes the idea of deliberative democracy where people of differing backgrounds meet at the public square to discuss issues that the community faces.

6.3 Concluding Reflections

Naomi Klein (2014) makes an interesting observation regarding the ways in which climate change is leading to a “mistiming” in the foraging and mating seasons of many species. Caribou accustomed to foraging in a region during a particular interval are, due to unseasonable warming trends leading to premature sprouting/blooming, arriving too late and finding no food. The spread of neoliberal policies of massive deregulation, privatization of public utilities and services, and the dismantling of social safety nets across the globe coincided with acutely noticeable changes in the climate. The neoliberal approach fragmented communities and encouraged corporate dominance just when society needed to scale back corporate influence and engage in community collaboration in order to reverse trends that were leading to climate change.

Climate change detonates the ideological scaffolding on which contemporary conservatism rests. A belief system that vilifies collective action and declares war on all corporate regulation and all things public simply cannot be reconciled with a problem that demands collective action on an unprecedented scale and a dramatic reining in of the market forces that are largely responsible for creating and deepening the crisis (Klein 2014:41)

Because modern denizens are no longer place bound, we tend not to notice the subtle changes in our surroundings that serve as harbingers of things to come (Klein 2014). A culture that transforms people into consumers is one in which place plays a much less significant role in identity formation than previously. This is not at all unrelated to energy/environmental issues because people who lack the sense of belonging to a particular place generally have little or no sense of stewardship. We have constructed a situation in which even those persons who feel a sense of belonging and ownership within their communities are often forced to leave due to loss of livelihood. These persons find themselves in a position in which their choice of habitat is driven almost solely by economic factors. It seems that the lack of connectedness to community and therefore an intimate knowledge of its subtleties accounts at least in part for the sheer sense of powerlessness that many feel in terms of having a stake in shaping the community's future.

Within the dominant frame in which we conduct research and policy, clearly the arguments I have outlined for charting a new course come across as whimsical or idealistic. Let me emphasize: *within the dominant frame*. Trapped inside of this frame, it is next to impossible to envision anything outside of it. Developing the moral imagination requires stepping outside the comfort zone of the dominant frame in which we are accustomed to operating. The very frameworks that help to bring a particular set of circumstances into being are the ones we must critique and abandon. The trouble with the technological proposals on the table for addressing the energy issue is that they were all devised within the context of the dominant framework. If we wish to change the ways we engage with the world and produce knowledge about it, we must disengage from the dominant frame in order to see how it shapes our attitudes. Werhane (2002) refers to this as “understanding the mental model or script dominating the situation” (34). One of the most powerful scripts is the progress narrative.

I am counting on the capacity of theory and praxis to work symbiotically to bring about lasting change. There are plenty of examples of changes in thinking that come about gradually through changed and changing practices. Locally-situated energy systems cooperatively owned and operated by community members combined with more public involvement in knowledge

production will gradually shift control away from corporate interests. Eventually, a change in thinking will ensue. After all, paradigm shifts, while some do occur dramatically and suddenly, take place only after the gradual accumulation of material changes reaches critical mass and it becomes obvious that the old paradigm does not work anymore. In a similar vein to Thomas Kuhn's (1962) "normal science," once the anomalies (in this case, new material practices) approach critical mass, we can expect a significant shift in perspective.

I find it apropos to draw attention to three critical works whose core message consists of an audacious and controversial critique of the prevailing economic model, a model that has encouraged the overextension of the human species and the relentless homogenization of the global habitat. Naomi Klein (2014) whose book, *This Changes Everything: Capitalism vs. the Climate*, I have cited at various junctures in this chapter; Thomas Piketty (2014) whose book, *Capital in the Twenty-First Century*, has captured more sales for Harvard University Press than any other book in the publisher's history; Karl Polanyi (1957) whose book, *The Great Transformation: The Political and Economic Origins of Our Time*, has experienced a renaissance over the past decade or so due to the import of its message. These authors deliver a message that is difficult to swallow, particularly for those who benefit the most from the existing system and who consequently stand to lose the most with a radical shift in a new direction.

Karl Polanyi describes the "Great Transformation" as that period in history when the market, no longer subsumed within and organized by society as it had been up to that point, became the organizing principle of society. In other words, the transformation occurred when the marketplace, no longer bounded by society, ultimately established the patterns and trends according to which society itself was aligned. Interestingly enough, the timing of this watershed shift (seventeenth-eighteenth centuries) corresponds to the time period that Michelle Foucault assigns to the significant transformations he outlines in *The Order of Things*.

Picketty takes the bold step of presenting a well-researched case that demonstrates a steady increase in the concentration of wealth amongst the world's richest (Hacker, Pierson et al. 2014) that runs headlong into one of the most dubious claims—"a rising tide lifts all boats"—undergirding trickledown economics. He audaciously proposes the implementation of a world tax on the world's wealthiest persons, something that would be tantamount to professional suicide within the discursive community of mainstream economists. While Picketty's insights

may have been laughed off during the heady days of the “Washington Consensus,” it seems that his book is as timely as it is bold in its implications.

Klein’s book, in showcasing climate change as an issue requiring immediate attention, encompasses both Polanyi and Picketty through the recognition that the factors leading to climate change are at base tied up with the dominant economic model and the unsavory fact that every domain of our society is organized according to its relentless demands. Particularly telling in this regard is her ironic indictment of the conservative mindset in her chapter entitled, “The Right is Right.” In a brilliant twist of irony, Klein demonstrates that conservatives, despite their public denials of anthropogenically-influenced climate change, not only accept the scientific consensus with regard to it, but they understand what is at stake.

Conservative institutes such as the Heartland Institute that specialize in climate change denial are very aware that a change in the public mindset is possible and has happened before. As such, they are doing everything possible to prevent such a paradigm shift from taking place. This is no insignificant revelation since what Klein suggests here is that conservatives are running scared because they believe it is very possible that fundamental change will indeed take place, and if it does, they stand to lose a lot. Meanwhile, what she calls “Big Green” (i.e. many environmental think tanks and institutes) actually promote policies and practices that tend to reinscribe existing consumption patterns and cavalier attitudes toward the habitat. The Left seems to be trying very hard to play both sides. Some green groups attempt to placate big business rather than holding their feet to the fire.

Clearly there are some daunting challenges that lie ahead which will act as a hindrance to many proposals for change until they are resolved. In the U.S., the influence of corporations over Congress, the Executive Branch, and the Judiciary presents a significant challenge toward implementing changes. A number of very large and powerful corporations (e.g. Koch Industries) have a significant stake in maintaining status quo fossil fuel extraction. Attempts to overturn the Supreme Court ruling on “Citizens United” (a ruling that has led to increased corporate influence over public policy) has already met with formidable resistance. The Supreme Court interpretation of a corporation as a person with many of the same rights but almost none of the same responsibilities as a citizen needs to be overturned, and corporate responsibility redefined

in such a way that flesh-and-blood humans will be held accountable for harms inflicted on communities (including nonhuman) by untoward corporate practices.

The policies of the World Trade Organization (WTO) require revisiting as they have hampered the efforts of some communities to localize businesses and guarantee jobs for the community by claiming that these initiatives represent unfair trade practices (Klein 2014). The WTO wields far too much power, and its policies have proven ruinous to indigenous communities through enabling international corporations to pillage the commons (i.e. the land, water, plants, etc. that are held in common by these communities).

Epilogue – Emerging Questions for Further Research

1 } Problematize the concept of “renewable energy”

How is “renewable energy” conceptualized by mainstream discourses, and how does this conceptualization legitimize energy sources that rely on harmful extraction practices? In theory, biofuels derived from perennial grasses and trees are renewable because they require few inputs to thrive and a single planting can provide multiple annual yields. Yet complicating the “renewable” question is the issue of scale. As I have shown, whether or not biofuels can be considered renewable depends on agricultural practices as well as the scale at which such practices are implemented. Perhaps nothing more saliently demonstrates the issues associated with blanket attributions of “renewability” to energy sources than hydroelectric power. Despite clear evidence that megadams wreak havoc on fluvial ecosystems, generate seismic activity leading to earthquakes, and result in the displacement of thousands of people and the erasure of cultural artifacts that date back millennia, hydroelectric power continues to be referred to as a “renewable resource” by the mainstream discourse (Lewis 2013; Orrego 2012). Indeed, China is on the fast track to construct a series of cascading megadams in an effort to substantially increase the nation’s proportion of electricity sourced by “renewables” by 2020 (Lewis 2013).

2 } Climate Intervention Schemes: what do these suggest regarding the way knowledge production should be organized?

How can climate intervention schemes be gaining in credibility in the face of research that increasingly demonstrates that “everything is enfolded in everything else”? The proponents of such schemes—increasing the albedo factor in clouds, increasing Arctic ice cover, simulating volcanic activity, etc.—many of them scientists of world renown, do not seem concerned about the ramifications of interventions that may bring about rapid changes in biogeochemical cycles that have historically been measured in geological epochs. Yet here again, the problem is framed in scientific/technological terms, turning it into a problem that only an elite cadre of highly-trained experts is competent to address. As for the public, few people are aware that their own future is being bargained away behind closed doors.

Climate intervention schemes are popular among those whose interests are tightly aligned with the fossil fuel industry. They are also gaining a foothold amongst those concerned about

climate change yet who see geoengineering as the only alternative to changing attitudes, perspectives, and behavior patterns. Still others would prefer geoengineering schemes to measures that would interfere directly with the choices of corporations and individuals. As Stephen Colbert put it in an interview with David Keith, a Harvard physicist and geoengineering proponent, “so you’re saying that I get to have my CO² and eat it too!” This raises the following questions: Why do people hang onto the illusion that humans can manage and control their surroundings? How does one’s experience of being-in-the-world inform one’s perceptions regarding the capacity (or even the desire) to dominate and control the nonhuman world? What kind of role do significantly monocultured and banalized living spaces play in shaping irrational illusions of control? How is it that such hubristic proposals appear within human capacity to manage? How do such irrational proposals gain credence among so many of the “well-heeled” members of society, and what does this suggest about the way the production of knowledge is organized?

3} Geography and Knowledge Production: How does the configuration of our *Lebensraum* shape the kinds of knowledge we value and the way we produce knowledge?

How critical are the spatial aspects of our existence to knowledge production? Stated differently, what is the relationship between the configuration of our living spaces and the way we make meaning of our existence? A concrete jungle as habitat provides a completely different perspective than regions that have not been built up in this manner. Each of these habitats or living spaces serves as a framework that influences the way knowledge is produced. Related to this is the prevalence of digital technologies that privilege disembodied, visually-apprehended “experiences” of the world. As research methods increasingly forego costly field work in favor of digitized databases and computer modeling, a new implicit framework is emerging that foregrounds and backgrounds in unique ways, “organizing our awareness to see and interpret the world in a particular way” (Green, Li 2011:1686). This additional level of mediation will have far-reaching impacts on the maps constructed by researchers since it privileges the “spectator” over the “participatory” aspects of knowledge production.

Appendix A – Categorical & Thematic Groupings

Part I: The following consists of a description of the categories that emerged during the initial inductive stages of my analysis which I then utilized the categories deductively to flag claims in publications and articles.

01} Advanced Biofuels

- ✓ The development of biofuels beyond second-generation (i.e. cellulosic) biofuels such as algae, municipal solid waste (MSW), methane from landfills, and fuels such as syngas and hydrocarbons from biomass that can be utilized with the existing automobile and distribution infrastructure (hence the term 'drop-in').
- ✓ Aviation biofuels

02} Agricultural / Forestry Practices

- ✓ Existing practices that are problematic and need to change, e.g., monocultures and tilling, heavy use of chemical fertilizers, pesticides, herbicides
- ✓ Practices required for the sustainable cultivation of energy crops, e.g., non-tilling to preserve soil organic carbon (SOC) and prevent soil erosion
- ✓ Potential problems associated with the extraction of agricultural/forest residue, e.g., soil erosion, loss of soil organic carbon (SOC), loss of valuable forest understory

03} Biofuels Processing / Production

- ✓ The various processes—e.g. thermochemical, biochemical—available for converting biofeedstocks into ethanol.
- ✓ Co-production of biofuels and the use of biomass to produce the heat required for processing
- ✓ Biofuels processing that includes the utilization of the protein-rich portion of biofeedstocks to produce livestock feed
- ✓ Co-products: use of distillers grains resulting from corn ethanol processing as livestock fodder
- ✓ Recommendations that calculations of the net energy efficiency of biofeedstocks incorporate a credit for co- and byproducts that would utilize more energy inputs if produced separately.
- ✓ Obstacles to commercializing second-generation (e.g. cellulosic) biofuels and/or to advanced/third-generation biofuels (e.g. drop-in fuels, hydrocarbon from biomass, municipal solid waste (MSW), algae).
- ✓ Development of thermochemical, biochemical, and other conversion processes for breaking down cellulose into starch.
- ✓ Limitations of vehicle fleet, distribution and storage infrastructure in accommodating proportions of ethanol that exceed 10% due to characteristics of ethanol.
- ✓ Lack of business confidence in market prospects due to high production costs and to capricious government incentives

04} Cellulosic (Second-Generation) Biofuels

- ✓ Benefits associated with using perennial grasses and trees and agricultural residue as biofeedstocks
- ✓ Potential of grasses like switchgrass and Miscanthus to enhance biodiversity
- ✓ The capacity of perennial grasses to retain soil water and to sequester carbon and thereby to decrease the need to utilize industrial farming practices to increase yields

05} Corn Ethanol

- ✓ Performance of corn ethanol in terms of carbon emissions
- ✓ Ecologically degrading farming practices and inputs utilized for corn cultivation
- ✓ Corn available as low-hanging fruit to meet existing biofuels mandates for quotas
- ✓ Hypoxic conditions in the Gulf, Chesapeake Bay, etc. due to extensive fertilizer application for corn cultivation
- ✓ How corn compares with fossil fuel and/or cellulosic biofuels in term of life-cycle assessments (LCAs) for GHG emissions.

06} Ecological Factors

- ✓ Impacts of cultivation of various feedstocks on soil organic carbon (SOC), soil nutrients, soil erosion, water quality and quantity, biodiversity.

07} Energy Security / Demand / Efficiency

- ✓ Decrease in dependency on volatile regions for continuing supply of fossil fuels cited as a key justification for transitioning to bioenergy/biofuels.
- ✓ Depletion of conventional fossil fuel reserves cited as reason to transition to bioenergy/biofuels
- ✓ Rising global aggregate energy demand raises the urgency of transitioning to biofuels
- ✓ Increases in efficiencies such as vehicle miles not enough and need to be combined with alternative to fossil fuels
- ✓ Promotion of innovations in energy efficiencies in order to mitigate aggregate demand

08} Food vs. Fuel Issue

- ✓ Concerns regarding the potential of energy crops to divert agricultural and land away from food production.
- ✓ Cellulosic biofeedstocks hold great potential as energy crops because these plants are not utilized for food and can be grown on land not utilized for food crops.

09} GHG Emissions / Climate Change

- ✓ Mitigation of GHG emissions cited as a key justification for transitioning to biofuels
- ✓ Mitigation of CO² and other emissions for the life cycle of the fuel (extraction, cultivation, processing, use)
- ✓ Impacts of climate change on agriculture and forestry

10} Land-Use / Land-Change

- ✓ land-use changes that may result from transitions in use brought about by the prevalence of energy crops.
- ✓ LUC issues associated with corn cultivation, sugarcane, etc.
- ✓ Impact of cellulosic energy crops on the land
- ✓ Challenges related to properly assessing LUC, particularly indirect LUC.

11} Impact Assessment & Measurement

- ✓ Life-cycle analysis (LCA) of biofeedstocks to measure carbon emissions from cultivation, processing, and use of the fuel
- ✓ The need to expand the LCAs to include measurements of the impact of biofuels/bioenergy cultivation on soil, water, and biodiversity, and on other GHG emissions (e.g. methane, nitrous oxide)
- ✓ Difficulties in measuring the impacts of indirect land-use change (iLUC)

12} Managing for Sustainability

- ✓ Planning and managing of ecosystems to insure sustainability into the future
- ✓ Use of models to forecast potential problems and plan/manage accordingly
- ✓ Plan/manage agricultural/forestry practices to insure protection of land, soil, water, and biodiversity as global demand for bioenergy/biofuels increases.
- ✓ Use of models to project land-use changes into subsequent decades
- ✓ Use of models to determine how specific agricultural / forestry practices may impact the land and to formulate recommendations for best practices

13} Marginal Lands

- ✓ Use of land considered unsuitable for conventional food crops on which to cultivate dedicated energy crops
- ✓ Capacity of cellulosic biofeedstocks to thrive on degraded or abandoned land

14} Political Instruments / Policies

- ✓ Effects of particular policies and/or regulations, e.g., how mandatory quotas for proportion of ethanol content in fuels has impacted ethanol production and/or spurred investment by industry.
- ✓ The need for particular policies to insure that certain biofuel/bioenergy goals are met
- ✓ The need for government incentives to insure necessary business confidence for biofuels investment and/or to "create" markets for biofuels.

15} Residue / Waste

- ✓ Promotion of the use of agricultural and/or forest residue as biofuel feedstocks
- ✓ Concerns regarding the ecological impacts of extensive extractions of agricultural or forest residue
- ✓ Research directed to the use of municipal solid waste, yard waste, methane from landfills, etc. as sources of biofuels/bioenergy

16} Rural Economy Stimulation

- ✓ Claims that biofuels/bioenergy will be good for rural economies because they will stimulate the creation of new jobs, pump money into the local economy, and provide farmers with new markets for their crops.
- ✓ Biofuels/bioenergy beneficial to subsistence economies in developing countries

17} Transport

- ✓ Potential of biofuels to significantly reduce GHG emissions from the transport sector
- ✓ Use of biomass (instead of liquid biofuels) to power an electric car fleet
- ✓ Contributions of the transport sector to global GHG emissions

18} Yields increase / genetic modifications

- ✓ Increasing crop yields can relieve pressure on land use
- ✓ Cultivating, breeding, and fuel production processes aimed at increasing per hectare yields
- ✓ Modification of plant photosynthetic cycle to produce more biomass

Part II: The following broad themes emerged from the categories defined in Part I. I utilize these themes in the form of questions in order to situate the knowledge claims in my analysis. Note that many of the categories overlap, with many of them encompassed by more than one theme.

Bioenergy/Biofuels Rationale: What are the most frequently cited rationales for transitioning the energy economy to bioenergy and biofuels?

- 07-Energy Security / Demand / Efficiency
- 09-GHG Emissions
- 16-Rural Economy Stimulation
- 17-Transport

Biofeedstock Assessment: Which feedstocks are being proposed as bioenergy/biofuel inputs, and what are the pros and cons of each?

- 01-Advanced Biofuels
- 02-Agricultural / Forestry Practices
- 03-Biofuels Processing / Production
- 04-Cellulosic Biofuels
- 05-Corn Ethanol
- 06-Ecological Factors
- 08-Food vs. Fuel Issue
- 09-GHG Emissions
- 10-Land-Use Change (LUC)
- 11-Impact Assessment & Measurement (LCAs, etc)
- 12-Managing for Sustainability
- 13-Marginal Lands
- 14-Political Instruments
- 15-Residue / Waste
- 16-Rural Economy Stimulation
- 18-Yields Increase / Genetic Modifications

Sustainable Management of Bioenergy/Biofuels: What are the primary issues, concerns, and proposals with respect to the capacity to sustainably manage biofeedstock cultivation, extraction, and processing?

- 02-Agricultural / Forestry Practices
- 03-Biofuels Processing / Production
- 04-Cellulosic Biofuels
- 05-Corn Ethanol
- 06-Ecological Factors
- 08-Food vs. Fuel Issue
- 09-GHG Emissions
- 10-Land-Use Change (LUC)
- 11-Impact Assessment & Measurement (LCAs, etc.)
- 12-Manage for Sustainability
- 13-Marginal Lands
- 14-Political Instruments
- 15-Residue / Waste
- 18-Yields Increase / Genetic Modifications

Commercialization of Bioenergy/Biofuels: What are the primary challenges to full commercialization of second-generation (e.g. cellulosic, residue, municipal waste) biofuels?

- 01-Advanced Biofuels
- 03-Biofuels Processing Production
- 04-Cellulosic Biofuels
- 14-Political Instruments
- 15-Residue / Waste

Appendix B – Sample Interview Questions for Biofuels Practitioners

This set of questions was composed for a representative of Greenpeace in Hamburg, Germany:

- Tell me about your role at Greenpeace and how you became involved with bioenergy/biofuels.
- Which aspects of bioenergy/biofuels are you most involved with?
- In your experience, what are the most frequently raised research and/or policy questions regarding the replacement of petroleum with biofuels?
- What types of questions or concerns are most commonly raised with regard to the cultivation of bioenergy feedstocks and land-use change?
- Looking forward into the next couple of decades, what do you foresee as presenting the most significant challenges related to the development, processing, and implementation of bioenergy/biofuels?

This set of questions was composed for a representative of the Verband der Automobile Industrie in Berlin, Germany:

- Tell me about your role at the VDA, particularly in terms of your involvement with biofuels.
- How is the biofuels solution situated within the context of other technological developments (e.g. electric cars) for reducing carbon emissions from the transport sector? For example, how much emphasis is put on biofuels vis-à-vis innovations aimed at automobile design?
- In your experience, what are the most frequently raised research and/or policy questions with regard to transitioning the transport sector to biofuels?
- What are the primary challenges faced by the auto industry, particularly with respect to the development of 'advanced' biofuels? For example, what implications does this have for engine design and/or optimization?

This set of questions was composed for a representative of the U.S. branch of the National Resources Defense Council:

- Tell me about your role at NRDC and how you became involved in biofuels/bioenergy. Which particular aspects of biofuels are you most involved with?
- What is the current status of the technological challenges faced with cellulosic recalcitrance? There seem to be varying opinions on this: some say full commercialization is just around the corner, while others express more conservative views.
- What about distribution and storage infrastructure challenges? What are the proposals for transporting and storing cellulosic fuels? Related to this: where are we at with combustion engine technology, e.g., how soon will a large proportion of the automobile fleet be equipped to support higher-blend biofuels?
- Can you comment on the complex relationship between biofuels and fossil fuels and how current and proposed policies may impact the situation. For example, with the insatiable energy demand you address in your 2010 article, even if enough biofuels are produced to meet the demand, the blends require the use of petroleum. And of course, if biofuels production is inadequate to meet demand, a bad situation (going after unconventional oil sources) will be exacerbated.
- You mention "rich incentives" in your 2010 publication, including incentives to get cellulosic biofuels online ASAP. What is your view on the significant direct and indirect subsidies associated with petroleum? What if the rich incentives included rolling back some of the oil subsidies and using the funds retrieved to fund the cellulosic biofuels incentives?

Appendix C – Circulatory Scaffolding

The following consists of four examples of the supporting apparatus referred to as circulatory scaffolding: 1) national institutional platforms (government agencies and departments); 2) international platforms (task forces, committees); 3) conferences, workshops, forums; 4) practitioner prestige and journal reputation.

#1: National Institutional Platforms: Government Agencies & Departments

The U.S.-based institutions most influential in shaping national policy and research priorities are the Department of Energy (DOE), the Department of Agriculture (USDA), and the Environmental Protection Agency (EPA). Often it is not useful or even possible to distinguish these agencies in terms of the circulation of knowledge claims. Much of the research utilized by these agencies is conducted on their behalf by think tanks, Institutes and consulting firms. Often these agencies post publications on their websites that originate from one of these other institutions.

Many of the biofuels communities of practice are located across multiple institutional platforms that are linked together either through research grants that specify the involvement of both institutions in a shared endeavor and/or through a publication resulting from the sponsorship of multiple institutions. In the U.S., specifically where biofuels are concerned, the Dept of Energy, the U.S. Dept Agriculture, and the Environmental Production Agency are jointly involved, either formally or informally, on a number of endeavors. Adding to the complexity is that these institutions collaborate very closely with academia. For example, the DOE runs a number of labs across the country, some of which are closely affiliated with universities, e.g. Oak Ridge National Lab (ORNL) works closely with the University of Tennessee on biofuels/bioenergy research endeavors, and Argonne National Lab partners with Northwestern University, Purdue University, and the University of Wisconsin-Madison.

Although the German-based institutional connections are not as clear-cut, I was able to make sense of these by reviewing the publications and institutional platforms from which these were derived. The institutions most influential in terms of national environmental and energy policy are the Umweltbundesamt (UBA), the U.S. equivalent of the Environmental Protection Agency, the Bundesministerium für Umwelt, Naturshutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety), and the Deutsche Energie-Agentur (Dena) (the Germany Energy Agency).

Much like in the U.S., the German-based version of the EPA, the Umweltbundesamt (UBA) outsources much of its research to other institutions. In this regard, the Institut für Energie und Umwelt (IFEU) and the Öko Institut play a significant role. These institutions also do research and consulting for the Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) (The Federal Ministry for Environment, Nature Conservation, and Nuclear Safety).

#2 International Platforms: Task Forces & Committees

One of the primary means through which practitioners from U.S., Germany, and multiple other regions come together to exchange, negotiate, and produce knowledge is through international task forces and committees that are established with specific goals in mind. The two most noteworthy examples are the Global Bioenergy Partnership (GBEP) and the Roundtable for Sustainable Biofuels (RSB).

Headquartered in Rome, Italy, the GBEP was formed in 2005 as an international organization dedicated to the promotion of global high-level policy dialogue on bioenergy and to facilitating international cooperation. The GBEP has formed several task forces to

address bioenergy sustainability, biofeedstock cultivation and processing, and to developing tools for adequately assessing life-cycle GHG emissions. GBEP partners comprise 23 nations and among the 14 international institutions are the World Bank, the Food and Agricultural Organization, the United Nations Environment Programme, and the International Renewable Energy Agency. GBEP provides a forum for consensus building and information exchange between nations. It is anticipated that GBEP performs a valuable service by “providing science-based measurements useful for informing national-level policy analysis and development” (GBEP, 2012).

Though clearly disputes and disagreements arise during roundtable sessions, the practitioners participate in the same thought collective and therefore share the same symbolic universe. For instance, as indicated by the previous GBEP statement regarding the provision “science-based measurements,” all participants embrace similar norms and practices of knowledge production pertaining to biofuels.

The knowledge claims of the practitioners that serve on GBEP task forces and committees are widely circulated through the support of the institutional platforms of the nations they represent.

The Roundtable on Sustainable Biofuels (RSB) was formed as a global platform for the purpose of bringing together multiple international stakeholders to work on consensus building with respect to the sustainable production, conversion, and use of bioenergy/biofuels. The work of the roundtable involves developing sustainability indicators that can be utilized to assess sustainability. The highest decision-making body of the RSB is the Assembly of Delegates. The practitioners belonging to the Assembly represent various institutions, among them corporations, e.g., Boeing, Lanzatech, Swiss Airlines, Nippon Biodiesel Fuel Co.. Additionally, the biofuels practitioners that represent these organizations are generally highly-trained experts and are often occupy senior management or senior scientist positions in the firms they represent.

#3: Conferences, Workshops, and Forums as Circulatory Platforms:

- a. *Workshop on Aquatic Biomass (International – Germany-hosted)*
- b. *ESA Conference on Ecological Dimensions of Biofuels,*

This case provides a valuable illustration of how practitioners coming together at a conference and producing publications as a result, participate in circulating a system of knowledge claims. In these two cases, one based on Germany, the other two based in the U.S. the conference and/or workshop sponsors involve prominent institutional platforms and the participants are quite renowned and significantly established in the field. As such, the follow-up of conference proceedings, workshop conclusions, and publications provided a significant impetus to the circulation of knowledge claims.

The international workshop entitled, “Aquatic Biomass: Sustainable Bioenergy from Algae?” was hosted by the German Federal Environmental Agency (i.e. the Umweltbundesamt), at its Berlin office in 2009. The workshop was organized by the Öko-Institut, the Institut für Energie und Umwelt (IFEU), both of these German-based institutions that do research and provide consultation for government agencies and ministries such as the UBA and the BMU. The workshop was sponsored by these German federal ministries/agencies: Federal Ministry of Education and Research, Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, and the Federal Environmental Agency (UBA). The objective of the workshop was to:

“bring together key representatives from countries active in research and development of algae-based bioenergy, to present and discuss the current status and future options of algae use, introduce relevant technology prospects and discuss environmental and development issues. From that,

open questions will be identified, and perspectives for further work will be considered" (Hennenberg, Fritsche, et al., 2009:1).

The workshop's international flavor was evidenced by the participants, although as might be expected, German participants dominated, at least numerically. Of the approximately 20 participants, 9 represented Germany-based platforms, 2 U.S.-based platforms while the rest were a diverse mix representing France, Italy, Korea, Thailand, Chile, Argentina, Brazil, Mexico, and Israel. A fairly substantial issue paper was prepared in advance of the workshop through the collaboration of seven practitioners, four of these from Germany, with the other three from Chile, the U.S., and Thailand. Many of the participants are affiliated with academic institutions while others represent environmental and energy institutes, and there were several representing corporate enterprises. The content of the issue paper and the workshop outcome report indicate that the practitioners addressed mostly technical issues related to algae cultivation, fermentation, and processing. The questions arising from the workshop address technical, economic, and environmental feasibility with regard to regions and inputs for cultivation, and with potential consequences associated with genetic modifications to increase yields.

The conference entitled, "Ecological Dimensions of Biofuels," was held in March 2008 at the Ronald Reagan Building and International Trade Center in Washington, D.C. Among the sponsors of the conference are the USDA, the DOE, and the Energy Foundation. Also included among the sponsors are the Union of Concerned Scientists, the Natural Resources Defense Council, the American Petroleum Institute, and the American Forest and Paper Association. There are other sponsors listed, but these appeared to be the most significant for the case at hand.

The ESA is a society of professional ecologists, the goals of which include communicating ecological science to policymakers. Among the governmental recipients of the knowledge claims circulated by the ESA via its Public Affairs Office is Congress. The ESA publishes four environmental journals that are among the leading journals circulating knowledge claims pertaining to emerging environmental issues. In view of this goal, the need for practitioners to distill their knowledge claims for consumption by an audience consisting of many non-practitioners is important to recognize. The research findings, interpretations, and opinions expressed by practitioners who belong to the ESA influences DOE, USDA, and EPA practitioners and non-practitioners alike and vice versa. Additionally, some of these practitioners participate in the Global Bioenergy Partnership (GBEP) international forum, either directly through meetings and presentations or indirectly through reports submitted to the group.

Many of those invited to speak are affiliated with several institutions including academia, U.S. DOE, USDA, and others. A quick perusal of the conference bios, abstracts and the four of the ESA articles that emerged from the conference and workshop demonstrate that a system of knowledge claims characteristic of what I describe in this and the following chapter as the "mainstream" discourse is circulated by biofuels practitioners with the aid of considerable institutional backing or support. As you can see by figure 2, the conference received considerable backing from some "heavyweight" institutional platforms, including three U.S. departments/agencies—U.S.DOE, USDA, EPA—that are significantly involved in energy and environmental matters.

Important to note in all of the above workshops and conferences is that all of the participating practitioners are science, engineering, or policy experts of one sort or another. Although the type of expertise varies by each practitioner (different types of scientists or engineers), the overall tenor of expertise (i.e. some kind of formal academic training) remains constant. In other words, no alternative expertises, e.g., those offered by indigenous groups, were represented among the practitioners who took part in these conferences and workshops. Even academically trained critical social scientists were not represented at these conferences and workshops.

#4: Practitioner Endowments of Circulation and Journal Prestige

In this case, I demonstrate how knowledge claims get circulated through the publication and citation process. As my search and review of publications progressed, I discovered some patterns with respect to publishing venue, frequency, and citation. For example, I developed a familiarity with a handful of biofuels practitioners who have authored multiple publications in varying venues. For example, a prominent landscape ecologist employed by Oak Ridge National Labs (ORNL)—a Dept. of Energy facility—has authored and co-authored numerous articles published directly by the DOE and by various academic environmental and policy journals. And the journals that have published this scientist’s articles rank in the top tier of mainstream environmental science and environmental policy journals—e.g. *The Journal of Environmental Management*. The following table consists of a listing of the most prominent practitioners and the institutional platforms with which they are associated:

Biofuels Practitioner	Primary Institutional Platform(s)	Secondary Institutional Platforms
Germany		
Uwe R. Fritsche	Öko-Institut	Umweltbundesamt (UBA) Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)
Klaus J. Hennenberg	Öko-Institut	Umweltbundeasmt (UBA) Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)
Guido Reinhardt	Institut für Energie und Umwelt	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)
U.S.A		
Bruce E. Dale	Michigan State University Great Lakes Bioenergy Research Center	Department of Energy
Virginia H. Dale	Oak Ridge National Lab / Dept. of Energy University of Tennessee	Environmental Protection Agency
Nathaniel Greene	National Resources Defense Council	Department of Energy Department of Agriculture
Keith Kline	Oak Ridge National Lab / Dept. of Energy	Environmental Protection Agency
Liz Marshall	World Resources Institute	Department of Agriculture

A search utilizing Google Scholar and/or the Web of Science reveals that these same practitioners have been cited by numerous other biofuels practitioners. This phenomenon provides insight into one of the most common ways in which knowledge claims get recirculated and ultimately make their way into the realm of indisputable premises or facts. Of course, it is worth noting that because many citations consist of paraphrases rather than direct citations, knowledge claims undergo varying degrees of transformation through repeated recirculation. And even direct citations rendered within a differing context can

take on new meanings. As such, those claims that achieve the status of indisputable claims lose their moorings in contingency and disputable hypotheses.

Another interesting pattern in circulation relates to single publications that have gained such prominence in the field that they function as a “gold standard” for practitioners wishing to establish credibility in their community of practice. To cite one such example: the publication—“Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply”—was published by Oak Ridge National Labs in 2005. A Google Scholar search reveals over 1400 citations for this single publication, with more than 330 of those occurring from 2012 forward. An article published by the Ecological Society of America (ESA) entitled, “Biofuels Implications for Land Use and Biodiversity,” published as recently as 2012 garners 66 citations on Google Scholar and approximately another 10 or so from the Web of Science engine that were not picked up by Google Scholar. This article reveals linkages between U.S.-based and Germany-based discourse as the search results show that the article has been cited by several Germany-based practitioners.

A Germany-based article—“CO² Mitigation through Biofuels in the Transport Sector”—published by the Institut für Energie und Umwelt (IFEU)—shows 65 citations on Google Scholar, with many of the citing practitioners based in various regions of Europe, Asia, and South America. I suspect that a European-based search engine may bring up many more citing practitioners as this article was first published in the German language.

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