

Greenwashing “Brown Gold”: A Critical Analysis of Anaerobic Digesters
and California’s Neoliberal Environmental Programs in Wisconsin’s
Dairyland

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Abstract

Large dairy farms, also known as concentrated animal feeding operations (CAFOs), have turned to anaerobic digesters as the industry is increasingly pressured to find ways to lower their greenhouse gas emissions. Digesters are machines that turn animal waste from CAFOs into electricity and fuel which are then sold as “credits” in California’s market based climate change mitigation programs such as cap and trade and the low carbon fuel standard (LCFS) program. However, this dissertation not only challenges the assertion that digesters are “green,” but also that these programs are doing what they claim to do in a deregulated and re-regulated neoliberal state. CAFOs produce billions of pounds of animal waste annually that pollutes the environment and sources of drinking water for rural communities. Using interviews and comparative historical analysis, I show how despite the many problems surrounding digesters, they became the go-to climate solution for CAFOs. My goal is not just to show how capitalists use technology historically, but how they need the state to fund, build, and “lock-in” contested technology. Neoliberalism strengthened a state/science/industry nexus by encouraging public-private partnerships to develop digester technologies for use in the private sector. My findings indicate that the state was not only instrumental in the research and development of every type of digester technology used by the private sector today, but they were also central in creating the markets for them to profit from that technology. In the state of Wisconsin, which is the second largest dairy producing state in the US behind California, digesters that were used in state sponsored market based programs decades before are now being repurposed to spur on what the dairy industry is calling “a manure gold rush” for programs in California. But if states have been encouraged since the 1980s to “think like a market,” who is thinking like a state? In California’s marketized environmental program, markets themselves have stepped in as regulator. The outcome of this arrangement is a system that marches forward in the name of climate progress, yet no one can be held accountable for its failures, particularly related to environmental injustice.

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List of Abbreviations and Acronyms

AAA	Agricultural Adjustment Act
ADM	Archer Daniels Midland
AFBF	American Farm Bureau Federation
APA	Administrative Procedure Act
ARB	California Air Resources Board
ARS	USDA Agricultural Research Service
BBA	Gramm–Rudman–Hollings Balanced Budget Act of 1985
CAA	Clean Air Act
CAFO	Concentrated animal feeding operation
CCM	California Compliance Market
CDM	Clean Development Mechanism
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH ₄	Methane
CO ₂	Carbon dioxide
CWA	Clean Water Act
DoE	US Department of Energy
EPA	Environmental Protection Agency
EWG	Environmental Working Group
FSA	Farm Security Administration
GHG	Greenhouse gas
IATP	Institute for Agriculture and Trade Policy
IPCC	Intergovernmental Panel on Climate Change
IRA	Inflation Reduction Act
LCFS	Low carbon fuel standard
LGU	Land-grant university
N ₂ O	Nitrous oxide
NASS	USDA National Agricultural Statistics Service
NAEMS	National Air Emissions Monitoring Study
NMP	Nutrient management plan
NOV	Notice of violation
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRDC	Natural Resources Defense Council
OMB	Office of Management and Budget
PD	Project developer
PPP	Public-private partnership
R&D	Research and Development
rbST	Bovine growth hormone

RFS	Renewable Fuel Standard
RIA	Regulatory Impact Analysis
RNG	Renewable natural gas
RTF	Right to Farm
SRAP	Socially Responsible Agricultural Project
UN	United Nations
USDA	US Department of Agriculture
VB	Verification body
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollution Discharge Elimination System
WPSC	Wisconsin Public Service Commission

Chapter 1: Introducing Methane Digesters as a “False Solution” to Climate Change

Section 1.1: Methane, Markets, and False Solutions

In 2022, the most recent Intergovernmental Panel on Climate Change (IPCC) report (2022b) explicitly emphasized the importance of reducing methane (CH₄) emissions in the short-term. Methane is concerning in the short term because it has 84-86 times the heat trapping capacity than CO₂ within the first 20 years and 28-34 times the heat trapping capacity over 100 years (Jackson et al. 2020). Methane is currently the second largest driver of climate change behind carbon dioxide (CO₂) (Bredariol and Schulz 2022). According to Martina Otto, the Head of the Climate and Clean Air Coalition at the United Nations (UN) (CCAC Secretariat 2022), “The first half of this century, the next 25 years or so, the temperature trajectory is going to be strongly governed by what we do for methane.” Yet methane emissions have increased 9 percent between 2008-2017 alone (Voiland 2020).

Agriculture is the leading source of methane emissions in the world (IPCC 2022b). The meat and dairy industries alone produce almost a third of global methane emissions (Ahmed et al. 2019). To highlight the scale of these industries, a recent report from the Institute for Agriculture and Trade Policy (IATP) and the Changing Markets Foundation (2022) found that fifteen of the largest meat and dairy companies produce about as much methane as the entire European Union. The Dairy Farmers of America, the largest of many dairy cooperatives in the US, produces more methane emissions than the entire United Kingdom (IATP and Changing Markets Foundation 2022). Despite this fact, the Biden Administration’s current methane reduction plan almost exclusively targets the fossil fuel sector (Morris 2021; White House Office of Domestic Climate Policy 2021).

The central focus of this dissertation is the primary “fix” used for the dairy industry: anaerobic digesters. Digesters are machines which are purported to reduce the methane content of animal manure by heating it up to a high temperature and flared (which emits as carbon dioxide instead of methane) or it can be used to create electricity and/or heat to power the farm that is running the digester (AgSTAR 2022a). Within the last 5 years, these digesters have increased production of something much more valuable: a “green” fuel source called renewable natural gas (RNG) which the industry is referring to as “brown gold” (Howard 2018; Cohen 2022). But the dairy industry also finds value in manure digesters for another reason. To quote the USDA (2010):

Anaerobic digesters actually provide two-fold greenhouse gas reduction. First, they capture methane that otherwise would be emitted from the manure into the atmosphere. Second, by utilizing the trapped biogas as a renewable energy source, digesters displace the need for additional fossil fuels. In addition, digesters eliminate odor, reduce air pollution, kill disease-causing bacteria, and improve water quality.

Digesters are framed by industry and the state as a technology that will address all of the dairy industry’s problems which I have bolded in the statement above.

However, this dissertation draws from discourse used by grassroots organizations and contends that digesters are a “false solution” to climate change, particularly for rural communities which continue to bear the brunt of air and water pollution from CAFOs. Liliston and Murphy (2022) appeal to chemistry to conceptualize a false solution:

In chemistry, a “true solution” refers to solutions with elements that mix to form an indistinguishable liquid. You cannot see the different elements, nor filter them out. In contrast, a false solution — what chemists more often call a “suspension” — still shows its component parts. For example, oil mixed with water creates a suspension rather than a solution... False solutions typically focus on just one or two dimensions of a complex challenge; they ignore the rest, even at the cost of undermining our broader objectives for climate and biodiversity.

According to Lilliston and Murphy (2022), false solutions can be identified by the following characteristics. First, they slightly alter a few aspects of the existing system but not enough to result in enough GHG reductions necessary for change. Similarly, second, false solutions can cause “net harm” by decreasing emissions while increasing some other environmental impact that causes harm. Third, false solutions often entail promises that a certain technology will “one day” be able to provide fixes for all of industry’s pollution problems. The prioritization of unproven and contested technologies ultimately takes time and money away from more immediate actions (Lilliston and Murphy 2022). Finally, a false solution imposes costs and risks, many of which are not fully understood, on actors with less political power.

Drawing from scholarly literature within political economy, political ecology, history, agricultural engineering, soil science, public health, epidemiology, critical agrarian studies, and science and technology studies, this dissertation provides a critical analysis of digesters as a “climate solution” for agricultural emissions particularly because the current sites for these technologies, concentrated animal feeding operations (CAFOs) rely on the externalization of their pollution, such as the emissions and water pollution from animal manure, in order to continue to operate. These choices have real environmental and health consequences for rural communities (Cowley and Brorson 2018; Gittelsohn et al. 2022).

When used at the right time, in the right place, in the right amount, animal manure has proven to be an invaluable source of nutrients for growing crops for centuries. However, Food and Water Watch (2020) estimates that CAFOs in the US produce over 442.5 million tons (or *885 billion pounds*) of manure every single year. With CAFOs, “[w]hat once was a win-win situation—animal wastes fertilized the crops that fed the animals in a relatively ‘closed loop’ system with relatively insignificant pollution resulting—has become a substantial environmental

problem,” (Angelo and Hennes 2013: 38) Political economists call this problem the “metabolic rift” which is shown in figure 1.1 (Foster 2002; Gunderson 2011). According to Marx, as production becomes increasingly industrialized and separated into different processes, capitalist agricultural production has a tendency to cause rifts in the soil cycle and environmental problems as a result.

Indeed, CAFOs have only begun to experience scrutiny related to their methane emissions within the last decade, but they have been challenged for much longer by rural communities and public health experts because of their impact on the environment, and in turn, human health (Hribar 2010; Merchant 2005; Burkholder et al. 2007). Methane is certainly important, but CAFOs also emit air pollutants that are toxic for human health such as ammonia, particulate matter, and hydrogen sulfide, which smells like rotten eggs (Center for Disease Control 2019). The odors that permeate from these facilities are so strong that, depending on the distance to the CAFO, they can induce nausea and headaches within minutes of exposure (Kolbe 2013). In Wisconsin, a state with a long history of dairy farming and the second highest dairy production rate in the US, surveys of rural residents showed that living near a CAFO was associated with lower lung function and high asthma rates within 4 miles of a dairy CAFO (Schultz et al. 2019). Similar results have been reported in North Carolina, particularly around low income and minority communities (Wing and Wolf 2000). On top of the air pollution caused by CAFOs, their waste storing and spreading practices have poisoned lakes, rivers, and groundwater sources which many rural communities still rely on as the only source of clean drinking water for their households. When manure runs off from fields and into local water sources it contaminates water with fecal matter, bacteria, pathogens, heavy metals, pesticides,

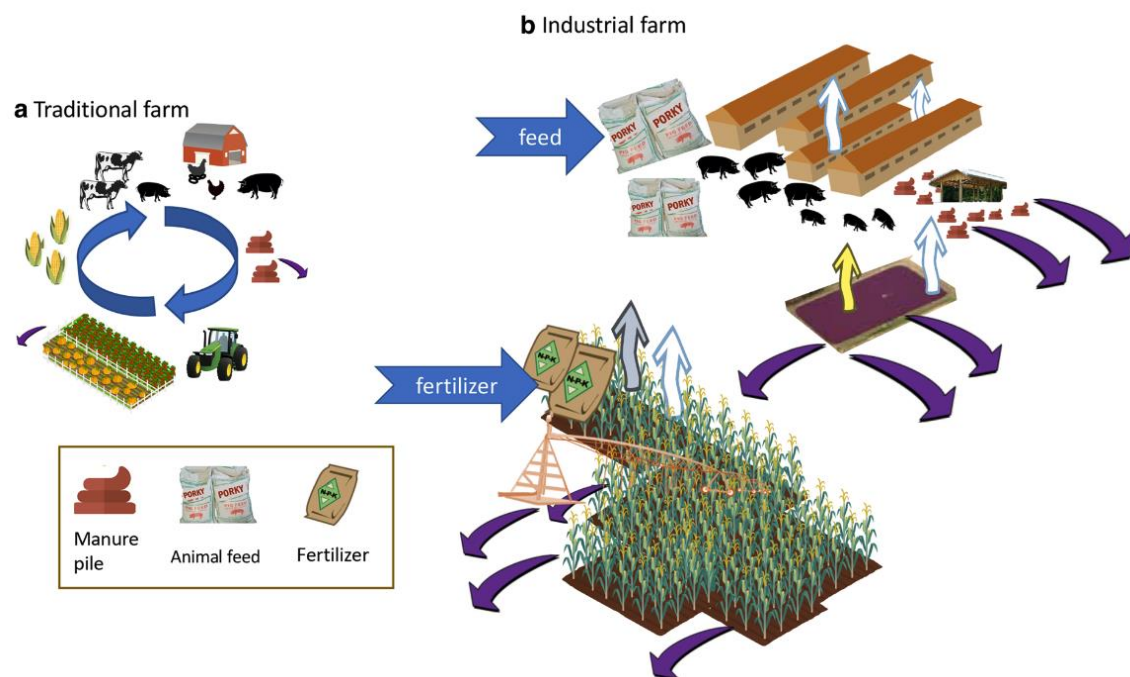


Figure 1.1: A visualization of the differences in nutrient flows between (a) traditional agriculture and (b) industrial agriculture which lead to metabolic rifts (Glibert 2020)

and nitrates— all of which have negative effects on human health (Lin et al. 2023; Huang 2018; Richards et al. 2022; Burch et al. 2021).

To understand why corporations and states have favored solutions that encourage “business as usual” we must grapple with the impact of neoliberalism, both in terms of neoliberal policy and neoliberal governance, on the practice of environmental regulation. Over the past 40 years, at the same time as the concentration of GHGs was rising rapidly within the Earth’s atmosphere, state governments across the Global North, including sub-national spaces within the United States (e.g., Wisconsin and California) have adopted a policy perspective that explicitly limits their ability to meet the goals of the climate crisis: neoliberalism.

Neoliberalism is difficult to define, partly because scholars have analyzed various dimensions of neoliberalism in so many different ways (Peck and Tickell 2002; Harvey 2005; Epstein 2005; Harris and Seid 2000). I find it useful to draw from Centeno and Cohen’s (2012) definition of neoliberalism as comprised of, “(a) a technical policy debate regarding the best mode of operating an economy; (b) an institutionalized crisis containment strategy involving political choices and power,” (318). In terms of the first part of the definition, neoliberal ideology challenges the historical practice of regulation that favored a centralized regulatory system with established standards for specific pollutants (Shamir 2016). A neoliberal state actively encourages the elimination of regulations to break down the state institutions, policies, and programs that were built up during the 1930s-1960s (i.e., deregulation) in order to replace them with institutions, policies, and programs that advance the “free market” and the accumulation of capital in general (i.e., re-regulation) (Aalbers 2016; Jessop 2002; Peck and Tickell 2002).

The second part of Centeno and Cohen's (2012) definition addresses the actual practice of neoliberal environmental governance. As highlighted by Pellizzoni (2011), "From fisheries quota systems to agricultural trade liberalisation, from water supply privatisation to the commodification of genetic resources, from carbon offset schemes to the sale of ecological services, there is ample evidence of a major shift in environmental governance," (795). Neoliberal environmental governance describes a regulation framework focused on, "increased participation of non-state actors in shaping public policy, public-private collaboration, the interaction of multiple spheres of authority, and noncoercive legal orchestration," in matters related to environmental regulation (Shamir 2010). The governance framework for regulation is embraced by industry because it encourages the state to govern in industry-friendly ways. Specifically, neoliberal governance reshapes the power of the state by shifting away from the traditional understanding of the state as an adversarial force that aims to ward off the worst industry actions through regulations. Instead, neoliberal environmental governance encourages cooperation between the public and private sector (also called public-private partnerships or PPPs) through non-state certification programs, voluntary regulations, market based regulations that benefit corporations. This also includes the use of "non-adversarial dialogue and organizational learning, presumably leading to the development of principles, guidelines, best-performance standards, and various soft law instruments," (Shamir 2010: 534).

While the focus of my Masters thesis was deregulation (D'Onofrio 2022), in this dissertation, I add an emphasis on re-regulation through neoliberal governance. California's climate change mitigation programs are a prime example. To provide some context, the US does not have its own federal climate change policy program. California may be just one state in the US, but they have decidedly taken the lead when it comes to US climate change policy by

creating their own carbon markets (Bigger 2015). Since California is the most populated state in the US and the fifth largest economy in the world, when something is regulated in California, it impacts a significant number of actors in the private sector (Plumer 2022). California not only has a program which allows companies whose GHG emissions are regulated by CA invest in projects that use digesters to “offset” large amounts of real GHG emissions, but also has a biofuels program called the Low Carbon Fuel Standard program, which created a market for the sale of RNG in the state of California (ARB 2020).

However CAFOs are hardly as regulated as fossil fuel companies. In the US, the largest livestock production facilities in the US, also known as concentrated animal feeding operations (CAFOs) are not required to monitor and report their GHG emissions to the EPA even if they release air pollutants that exceed the limits of the Clean Air Act (Jones et al. 2017). This has been the case for the last 15 years. As I discuss in more detail in chapter 5, when the overall emissions reductions from digesters are taken into account, the amount reduced does not even put a dent in the overall methane emissions from the livestock industry. According to AgSTAR, in 2020 methane digesters on farms resulted in the destruction of 5.26 million metric tons of carbon dioxide equivalent such as methane (AgSTAR 2022c). However, in 2021, the methane emissions from enteric fermentation and manure management in the US was over 265 million metric tons of carbon dioxide equivalent (EPA 2023). This means that methane digesters in 2021 only reduced 2.3 percent of methane from these two sources of methane from animal agriculture in the US.

As I mentioned above, it is not only the private sector extolling the benefits of digesters, it is also the state. Considering the window of opportunity for addressing climate change is closing, it is crucial to identify false solutions as a means to avoid a phenomenon that is referred

to as “lock-in.” According to Perkins (2003), lock-in describes the ways that, “...technologies and technological systems follow specific paths that are difficult and costly to escape. Consequently, they tend to persist for extended periods, even in the face of competition from potentially superior substitutes,” (1).

Due to the rise of political pressure to create technological “fixes” to mitigate the impacts of climate change, there has also been a significant amount of research in relation to lock-in of technologies. Lock-in occurs in the context of what Cecere et. al (2014) refer to as “eco-innovations,” which aim to specifically improve the environment and increase sustainability (Oltra and Saint Jean 2009). Cecere et al. (2014) name lock-in as a “persistent characteristic” in the context of the development of eco-innovations. The first and most obvious reason for what causes lock-in, which was also highlighted by David (1985), is to avoid (new) sunk costs. Overall, without pressure from the state, industries have little incentive to invest in green technologies because of the irreversibility of the high costs of investment and implementation.

The importance of sunk costs as a barrier to the creation of green technology is a central focus of another area of literature within energy studies that specifically refers to “carbon lock-in” (Foxon et al. 2005). Carbon lock-in describes the institutional entrenchment of technologies that produce environmental pollution in the form of carbon emissions (Seto et al. 2016). The literature on carbon lock-in emphasizes the importance of sunk costs because fuel production is dependent on existing infrastructure, which in this case, disproportionately relies on the continued production and use of fossil fuels (Cortazar et al. 1998). Indeed, “The costs related to the adoption of a cleaner technology result in the persistence of an old technological regime, in which the existing knowledge, competences, infrastructure, and capital lead to entrenchment in a pollution-intensive trajectory,” (Cecere et al. 2014: 1045). In other words, due to the long legacy

of fossil fuel production and consumption, not to mention pro-fossil fuel research, investment, and policy up to the highest institutional levels across the world, it is incredibly difficult to shift away from fossil fuels on a large-scale.

Many technologies considered to be eco-innovations existed long before they were implemented. They remained within “technical niches” meaning they operated as experiments within highly controlled environments such as universities and research labs (Cerere et al. 2014). These are spaces of trial and error where technologies are still being improved and are not expected to immediately conform to the “harsh selection environment” of the market. Cecere et al. (2014) unknowingly highlight that most of the technologies considered to be eco-innovations emerged from technological niches, from hybrid cars to the phasing out of paint products with volatile organic compounds to the creation of solar panels, emerged from their respective technical niches because of some type of state intervention. Whether through the funding of research or the construction of costly infrastructure, the creation of green technologies in particular seems to necessitate some type of state involvement, particularly in the case of “agrifuel” production.

Drawing from Cerere et al. (2014) and also historical research by Gilbert (2015) and Busch (1982), I formulated the conceptual framework of the agricultural state/science/industry nexus as a way to think further about the dynamics that form when the state, scientists within these technical niches, and industry constantly interact with each other. The state/science/industry nexus of US agriculture describes the historical and contemporary interconnectedness of state knowledge producing institutions in the agricultural sciences and the private industries which have sought to use this knowledge to create, promote, and normalize technologies needed to surmount nature/labor barriers to capital accumulation within agriculture.

Historically, the agricultural industry has worked very closely with state knowledge producing institutions such as land-grant universities, Extension Service, and the US Department of Agriculture. The “nexus” enabled me to trace how these specific connections evolve over time.

Section 1.2: Layout of the Dissertation

Following this chapter is my methodology section. The central method used in this dissertation is comparative historical analysis and case study analysis, which are deeply complementary. Throughout this chapter, I present my research questions, research design, strategies of data collection and analysis, as well as a short reflexivity section to situate myself (and my biases) as a researcher within the context of my research. I also include a long discussion of the sources of data I used for this dissertation including the sampling process for my interviews with verifiers and regulators at the Department of Natural Resources in Wisconsin.

In chapter 3 and chapter 4, I introduce the theoretical foundations of the dissertation, which encompass two different bodies of research. Chapter 3 provides the theoretical orientation for Q1: How are CAFOs in Wisconsin with long histories of noncompliance able to participate in and benefit from California’s carbon reduction/market programs which require compliance to participate? To answer this question, I needed to bring in neoliberalism to show why marketized programs are being used in the first place and why privatization has become so common in environmental regulation. These background questions also needed to be answered in order to incorporate this dissertation within the literature of political economy and political ecology. In this chapter, I also provide background on the basic regulation of CAFOs to show how the state, particularly the EPA, has failed to step in and advance regulation that limits the pollution of

CAFOs. This chapter shows the diminished state of CAFO regulation today, not only on the federal level, but also in the state of Wisconsin where many digester projects participating in California's programs are currently located. Weak environmental regulation in Wisconsin undermines the legitimacy of California's programs, which merely require compliance with state and federal regulations.

In chapter 4, I present my theoretical framework of the agricultural state/science/industry nexus. I take a step back into history to show that long before neoliberalism emerged in the 1970s, there were already networks of actors within agricultural knowledge production whose goals gave a distinctive advantage to the largest and wealthiest agricultural producers. My goal here is to show that neoliberalism did not create these connections, but it did strengthen them, particularly when the practice of science became more privatized and focused on advancing global market competition from the 1980s onward. The second half of chapter 4 brings in theorization from critical agrarian studies to think through the relationship between the state, agriculture, capitalism, and technology. Specifically, I draw from Gillon (2016) and Goodman, Sorj, and Wilkinson (1987) to show how capitalist agriculture uses science and technology in certain ways (appropriationism and substitutionism) in order to continue capital accumulation. I then apply these concepts to two contemporary examples: rBST (the bovine growth hormone) and biofuels from ethanol. From this point on, the dissertation focuses on the importance of "agrifuels" as I shift towards focusing on biogas from digesters.

Chapter 5 includes the bulk of my comparative historical research on the nexus that addresses Q2: Who and what has driven or currently drives the research, development, and adoption of digesters on CAFOs as a "green technology" in the US and Wisconsin? Here, I used process tracing and archival documents to specifically identify when they were developed, who

developed early models of digesters (which institutions were involved), why they were developed, and where they were developed. I combine this process tracing with a breakdown of the discourses around digesters from within the nexus. These are mostly positive, but fail to reflect concerns around pollution from rural communities. In fact, many of the positive messages around digesters make them seem more “green” than they actually are.

In the final substantive, chapter 6, I take a look at California’s offsets and LCFS program to highlight contemporary drivers of digester adoption in the US and Wisconsin. These marketized and privatized programs are some of the few climate change mitigation programs that exist in the US. However, because they are set up in neoliberal ways using an incredibly deregulated industry as the site for “green” projects, these programs have serious limitations. I show these limitations through interviews with regulators in the state of Wisconsin as well as verifiers who had extensive experience working on CAFOs with offset projects.

Chapter 2: Research Methodology

Section 2.1: Introduction

While developing a dissertation, or any research from scratch for that matter, questions posed at the beginning evolve as we think, read, and learn more about the questions at hand. Before presenting the details of my research methodology, I once again bring in my research questions:

Q1: How are CAFOs in Wisconsin with long histories of noncompliance able to participate in and benefit from California's carbon reduction/market programs which require compliance to participate?

Q2: Who and what has driven/currently drives the research, development, and adoption of digesters on CAFOs as a "green technology" in the US and Wisconsin?

Each of these questions necessitated a different method to answer them, thus the rest of this chapter is organized correspondingly. I also made the choice to arrange these questions in order so my research "process" becomes clearer as a way to observe how my focus changed as my findings started informing the research during the research process itself.

For Q1 and Q2, I use case study research for my research design. Since Q1 is designed to address a specific event on a specific CAFO, I chose to use a single case study. To answer this question, I draw from interview findings with regulators in Wisconsin and verifiers within California's carbon markets. I also drew from regulatory documents and databases, primarily the ARB offset issuance table and the WDNR CAFO permit database. By combining what I knew about how to access these databases and the interview data with regulators, I was able to discover that Central Sands received credits for a period while it was actively violating environmental regulations four months before an investigation was announced by CARB. I

elaborate on these findings in chapter 6. For Q2, I employed a within-case study using comparative historical methods.

Section 2.2: A Note on Reflexivity

As researchers within the institutional setting of the university and key actors involved in knowledge production, we have a duty to analyze our own positionality, power, and privileges. Researchers, while they may have advanced training, still bring their own biases and privileges into the field. These impact not only the responses garnered by participants, but access (or non-access) to resources. Our positionality and habitus can even influence which research questions we decide to pursue. So who am I and how does it influence my research perspective?

- **Politics-** I consider myself an eco-socialist politically and these politics were influenced mostly by my father, the Great Recession, climate change, and my experience studying CAFOs. My dad was an ultra-conservative and eventually a Tea Party Republican. He maintained those politics even after he remained unemployed and underemployed for years after the Great Recession. Watching my parents and particularly my father struggle to reconcile with their individualistic political ideology influenced the critical stance I have related to capitalism. Because of my dad, my fascination with politics came at a young age. My experience with my dad also gave me a unique type of empathy for meeting people where they are politically as a starting point for social change. This perspective is useful considering in many areas, rural spaces continue to be dominated by conservative politics. For the “eco” dimension, I have been studying the impacts of CAFOs on communities for 9 years. Many people become interested in studying animal agriculture specifically because of the animals themselves and their own beliefs and values around the consumption of animals as food. Indeed, the first question I am usually asked when my research is brought up is “Are you vegan?” But my passion for this issue goes beyond the animals alone. It lies with the human communities themselves and my belief that everyone should have access to clean air and water and should be able to protect themselves from large underregulated industrial facilities that worsen their daily lives.
- **Education-** I think my education, besides my class and politics, most deeply influences my research perspective. I received my BA in law and society at the University of Delaware. The law and society perspective highlights the role of the law and the state in

the reproduction of social inequalities. Since then, I have consistently incorporated questions about the law and the state into my research. As I continued on as a masters student and then a PhD student in political economy, I began to incorporate more critiques of capitalism within my research. In other words, the more I learned about the state and capitalism, the more my perspective as a researcher began to change because I was willing to question more than I had before. I do not believe that scientists are ever truly objective, as I hopefully make clear throughout this dissertation. However, that is not to say that I conducted this research with preconceived notions. There is a substantial body of “legitimate” health research that shows the negative impacts of CAFOs on the environment and people, but this does not seem to matter for the “nexus” of capital, state, and science. The uninterrupted continuation of harmful practices in light of this evidence is ultimately why I decided to tackle this project.

- **Gender and Gender Identity-** I am a (white) cisgendered woman. I have always been acutely attuned to gender dynamics because I’ve never liked following gender norms. I realized early on that, even as a woman, I had to do masculinity while ALSO doing femininity in order to be taken seriously. As a result, I studied gendered microdynamics and the reproduction of inequality thoroughly when I got to college. Gender and the reproduction of gender is always on my mind although this is not an explicit dimension of my research.
- **Race-** I’m white. Rather than viewing race as a category which means “minority,” my research perspective on race mostly involves a critical analysis of whiteness. I see whiteness as a rich category of analysis which can always be applied to cases due to the historical political, economic, and social power of whiteness-- and oppression of everyone else-- embedded within the state and the law itself. In retrospect, my whiteness made it easier for me to complete this research. Not only are mainstream climate change organizations predominantly white, but so are the actors that work within the “offset space.” All of the verifiers I interviewed were white. Additionally, all of the regulators I interviewed at the WDNR were white. This speaks to the fact that Wisconsin itself is a predominantly white state in a heavily white region, the Midwest. The whiteness of these groups was actually part of the reason I found the case of Kewaunee County interesting when I first came upon it 9 years ago. Coming from the law and society discipline, race and racism was a central focus of study. At the same time I began studying environmental justice, I learned about environmental racism as the case of Flint became more publicized. When I discovered the issues in Kewaunee County, my first question was simply, “How is the state ignoring them? They’re white?” Over time, I realized that their whiteness was not enough to protect them from environmental pollution in mostly white spaces. Ultimately, I do not know if I could do my research as a person of color in rural spaces in the Midwest, and this is a privilege I deeply recognize.
- **Class-** I was raised in the middle class and I acknowledge that even though my funds are limited as a grad student, I am still privileged by the fact that I can reach out to my

parents for financial help if I needed it. I acknowledge that my class location gives me cultural resources that other groups do not have. However, I also connect my family's financial troubles to larger trends of neoliberalism over time including the rise of income inequality and the shrinking social safety net. My experiences around class have made me exceptionally skeptical of corporate activity. As a result, a huge focus of my research outside of this dissertation also includes the corporate takeover of family farms and the plight of small farmers, particularly dairy farmers, as they are continually pressured by global markets and the state to "get big or get out."

Section 2.3: Research Design and Case Selection

The overall research approach within this dissertation is comparative historical within a case study design. According to Yin (2003), case study research is particularly useful when these three conditions are present: 1) the study aims to answer "how" and "why" questions, 2) the researcher does not have the ability to control the events being studied, and 3), the study focuses on, "a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information," (Creswell 2013: 97). So, what is the case here? Again, that differs slightly from one question to another because the case represents the unit (or units) of analysis that are under investigation.

For Q1, I utilized the case study method in order to understand a specific event: the invalidation of offset credits by Central Sands Dairy farm in Wisconsin in 2020 (ARB 2020). Q1 is where the dissertation began. In my thesis and over the course of the last 9 years, I have been following the ways that neoliberal deregulation and reregulation of CAFOs in Wisconsin has negatively impacted the communities surrounding these facilities (D'Onofrio 2022). Wisconsin is very useful as a site for a case study for several reasons. First, up until 2019, Wisconsin had more methane digesters than any other state in the US, even California (AgSTAR 2022b). Second, Wisconsin is the second largest dairying state behind California. The farms that operate

the digesters are some of the largest dairy farms in Wisconsin with hundreds to thousands of dairy cattle per farm. Third, the state has a history of weak enforcement of environmental regulations around CAFOs since 1995. Since California effectively privatized the “boots on the ground” regulation by allowing third-parties to carry out most of the reporting and enforcement of these programs, a focus on digester projects in Wisconsin highlights the limits of these neoliberal arrangements within an already deeply deregulated state. But because this program is not in California per-se, I did not include CA as its own “case.” Rather, it is a case study of a project in Wisconsin that also includes relations to the state agency in California that regulates these programs, the California Air Resources Board (ARB).

In August of 2020, the Socially Responsible Agricultural Project (SRAP) released a research report on the various CAFOs in Wisconsin that were recipients of offset credits from California’s cap and trade program. A condition of earning credits is compliance with local and federal regulations. According to the regulation (CARB 2012: 2, emphasis added):

All compliance offset projects must be determined to be in conformance with all state, federal, and local environmental, health, and safety regulations applicable to the offset project location before ARB issues ARB offset credits... In addition, compliance offset projects *may occur outside the State*, and therefore, the regulatory conformance determination serves to ensure that projects credited under California’s program are meeting applicable regulations in the various states.

I was familiar with many of these CAFOs and their long histories of regulatory violations, so I was surprised to learn that they were able to receive credits at all. Pagels Ponderosa, for example, has earned over 105,000 credits, despite having, “17 manure spills totaling 66,600 gallons of manure, along with three permit implementation violations,” (SRAP 2020). Another offset project was on Central Sands Dairy in central WI. Similar to Pagels Ponderosa, Central Sands Dairy never obtained the air emission permits required to operate by the state of Wisconsin. In

terms of water pollution, Central Sands has issues as well. Indeed, currently Central Sands is being sued by 81 plaintiffs in Juneau County for groundwater contamination (Madden 2019).

If ARB finds out that these projects were not following regulations, they can initiate a process called invalidation (ARB 2012: 2):

The Regulation also includes a mechanism called invalidation that may be triggered after ARB offset credits have been issued. Even though ARB has a rigorous and multi-step review process prior to the issuance of ARB offset credits, subsequent new information may result in a determination that the ARB offset credits were generated from projects that did not conform to the requirements of the Regulation.

Since Wisconsin has a history of weak regulation and enforcement around CAFOs, I expected to find at least one case of invalidation on CAFO projects. I was still surprised to learn that since the program began in 2013, only five projects- out of the thousands of projects that have received offset credits- were invalidated. However, three out of the five cases of invalidation were dairy CAFOs, and two out of those three cases were in Wisconsin.

I decided to research these two cases more deeply. Before reviewing publicly available regulatory documents connected to the two cases of invalidation, I had assumed that the regulatory system of Wisconsin was at the center of issues around lack of regulation. But further investigation of ARB documents describing the conditions leading up to the determination of invalidation at Central Sands Dairy suggested this was only part of the issue. Although Wisconsin may have a weak existing regulatory system, that did not explain why both of these CAFOs continued to earn credits for years before ARB even noticed that the WDNR had reported them out of compliance (ARB 2020). This suggested that actors and organizations outside of the state, particularly project verifiers and designers, could also have a central role to play in the existence of dirty CAFO projects. I began to see how the problem may not be with

individual actors, but the entire process itself. Since this is connected with existing literature within political economy on the emergence of neoliberalism, particularly in relation to the privatization and marketization of state functions, I formulated Q1 to draw attention to these problematic dimensions of neoliberal environmental governance in the age of climate change.

But I still wanted to know more. I wanted to understand who (groups, institutions, key actors) and what (policies, events, etc) drove the buildup of digesters on CAFOs in the first place, both in Wisconsin and in general. I added a new component to the dissertation when I found Gillon's (2016) article discussing "who benefits" in the production of flex commodities such as biofuels. I realized that what I was interested in was not just the growth of large-scale CAFO agriculture, but the development of markets and technologies for *agri-fuel* in the era of climate change. In looking at the larger history of agricultural technology, specifically substitutionism to create one commodity from another, I realized that digesters were part of a longer legacy of agricultural capitalists seeking to find new ways to continue capital accumulation. These broader processes are not necessarily unique to WI as weak enforcement might have been.

This is when I developed Q2 regarding the larger social, political, and historical context around the creation and proliferation of offset and LCFS projects on CAFOs as a key climate change solution for the dairy industry. Q1 was by no means an event that happened overnight. The invalidation was seemingly (from my interview data) a painstaking and frustrating process between WDNR and ARB that stretched over a span of several months. However, to answer Q2 I went further by seeking to understand how a certain type of technology developed over a period of 50-60 years. Thus my units of analysis for Q2 were the digesters that operated on CAFOs. At this point, I recognized the need to shift to a comparative historical methodology in order to

understand when these technologies emerged, when they became normalized, and which entities were instrumental in these processes. I needed to trace all of these components to identify whether drivers of prior digester booms were different from the drivers today. This methodological shift enabled me to situate digesters within larger historical trends related to the political economy of agriculture.

Comparative-historical analysis (CHA) is an interdisciplinary methodology made up of 4 key elements. According to Lange (2012: 3):

Two are methodological, as works within the research tradition employ both within-case methods and comparative methods. Comparative-historical analysis is also defined by epistemology. Specifically, comparative-historical works pursue social scientific insight and therefore accept the possibility of gaining insight through comparative-historical and other methods. Finally, the unit of analysis is a defining element, with comparative-historical analysis focusing on more aggregate social units.

In a within-case study, researchers study a single case in detail as a way to deeply investigate a specific phenomenon. This is a more exploratory type of case study to use when the existing research on a particular subject is lacking. According to Mills, Durepos, and Wiebe (2010):

...within-case analysis begins with a rich/thick description of the data. However, the format of this descriptive portrayal may vary considerably. Within-case analyses can result in a graphic depiction, a narrative summary, a historical timeline, a sequence analysis, an overview of the central attributes of the case, a matrix, or countless other ways to depict the essence of an individual case.

In a within-case study, the units of analysis, the digesters on CAFOs, are still understood as single cases. The cases can be compared in order to highlight key similarities and differences between each different case of digester development once their detail is sufficiently understood.

CHA enables researchers to understand how processes and events unfold over time in several key ways and this is precisely why I chose CHR as a central research methodology. The first concept I found very useful for this research is path-dependence, also known as path-

dependency. According to Mahoney (2000), path dependence describes, “those historical sequences in which contingent events set into motion institutional patterns or event chains that have deterministic properties,” (507). This is not to say that once an outcome or event happens a certain “path” is inevitable. Throughout this dissertation, I trace several policy debates that build on each other from the mid-1800s up until today. Path dependency is a useful tool for this dissertation as a way to analyze which “solutions” are continually chosen over others, despite their shortcomings, as a way to study how power impacts the development of technology within state funded scientific institutions. As Pierson (2015) explains, one key way that power accumulates over time is through the redistribution of political resources based on who wins and who loses in policy debates. Winners, in this case, gain resources that the losers do not. Specifically, “New institutions or policy regimes are often the main prizes awarded to the victors during critical junctures,” (Pierson 2015: 135). The impacts are compounded if the winners are awarded in ways that redirect entire flows of resources in their favor. If the rewards for winners are continuous instead of a one-time event, this substantially increases the likelihood of positive feedback and thus, path dependence.

A term that is useful here which is often used alongside path-dependency theory, but particularly important in the context of theorizing science and technology, is called *lock-in*. The concept of lock-in was first utilized within evolutionary economics in the mid to late 1980s in reference to the implementation of technologies that are inefficient in the long-run, but become “locked-in” to industry standards (David 1985; Arthur 1988). A good example of this is shown through David’s (1985) historical analysis of the creation and standardization of the QWERTY keyboard. Despite the fact that the QWERTY keyboard resulted in the adopters actually typing slower than those who chose other keyboard formats available at the time, it still became the

“universal” keyboard for typewriters between 1895 and 1905 and remains the standard to this day. Since then, the term has been utilized within political science (Thelen 1992), development studies (Haider et al. 2018), political ecology (Watts 2015) and critical agrarian studies (Peluso and Purwanto 2018).

Another way to study the evolution of institutional power and technology is through the analysis of *critical junctures*¹. As noted above, power dynamics between groups typically do not change completely as the outcome of one event, but certain events can hold weight in explaining how those shifts play out. These events, called critical junctures, are, “relatively short periods of time during which there is a substantially heightened probability that agents’ choices will affect the outcome of interest,” (Capoccia 2015: 150). These events are short compared to the overall path, but still impactful because they have the potential to act as precursors to processes that eventually become path dependent (Capoccia and Kelemen 2007). For example, in chapters 4 and 5, I discuss how fuel crises were critical junctures because they entail heightened political and economic pressure and have repeatedly spurred the development of technologies and markets for alternatives to fossil fuels (Baines 2015; Lehrer 2009). Policy victories can act as critical junctures if they occur at the right place and time. If enough victories happen over time, these create path dependent outcomes.

The last technique from CHA I utilized for Q2 is process-tracing. Process-tracing, “...looks at how various social and political outcomes are produced by events that result from actors’ actions and interactions and various contextual factors,” (Bengtsson and Ruonavaara 2016: 46). It is a way to understand the causal mechanisms, rather than just causal effects, that

¹ A similar concept to critical junctures, which I employ in the last section of the chapter, is Lehrer’s (2009) concept of “policy windows.” Like critical junctures, these are “windows” in time where political contingency enables one group to capitalize on new opportunities that were previously considered out of reach before the juncture occurred.

connect one variable to another (Falletti 2012). More specifically, I use theory guided process-tracing which, “explains the outcomes of interest by going back in time and identifying the key events, processes, or decisions that link the hypothesized cause or causes with the outcomes,” (Falletti 2006: 5). Theory guided process-tracing brings together various other techniques from CHR, including path-dependency theory and critical juncture analysis, in order to understand how political outcomes unfold over time. For example, Bengtsson and Ruonavaara (2016: 48 emphasis added) used a comparative case study of national housing policies in 5 different Nordic countries to demonstrate how theory guided process-tracing is strengthened by the use of other techniques used in CHA:

...the basic characteristics of each country’s “housing regime” were identified, and, on the basis of this, the history of the country’s housing policy was investigated. Most important, *critical junctures* and *political focal points* were identified and analyzed, which had contributed to either the *path dependence* of national housing policies and institutions or to their change. The *social mechanisms* that made housing policies path dependent were identified, and an analytical *periodization* of the development of housing policy was applied to each national case.

In chapter 4, I draw from existing literature within political economy, political ecology, rural sociology, history, and critical agrarian studies as a theoretical framework to formulate a theory describing the deeply interconnected network of actors involved in the research and development of agricultural technology in the US. The literature indicates that the development of agricultural technology was fostered by a coalition of actors within land-grant universities, Cooperative Extension Services, regulatory agencies, and the private sector. I call this coalition of actors the “agricultural state/science/industry nexus.” In chapter 5, I take the conceptual framework of the nexus and use theory guided process-tracing to understand if the research and development of digesters fit within this framework.

As noted by Mills, Durepos, and Wiebe (2010), within-case studies often involve some “poking” around, but it is important to highlight that this was not “guess work.” Theory guided process-tracing necessitates that the researcher is already very familiar with the details of the case. For example, long before I began process-tracing, I familiarized myself with how digesters worked, their issues on CAFOs, the types of digesters in operation today, the extent of digester adoption in the US, the regulation of digesters, and the key actors and institutions driving the development and funding of digesters on CAFOs in the US. I show how this information was used in the next section where I discuss the sources of data and collection process used for Q2.

Section 2.4: Sources of Data, Data Collection, and Process of Analysis

In order to answer Q1, I started by focusing on the different groups of actors involved in the process of invalidation by drawing from the “final determination” report issued by ARB for Central Sands Dairy in 2020 (ARB 2020). In the first step to get a project off the ground, a project developer (PD) approaches the CAFO and proposes to set up and operate a digester project (ARB 2013). The project developer is responsible for being the “lead” on these projects since the CAFO owner is running the dairy itself. In this arrangement, the project developer approaches the farm and either offers them consulting services for a fee, a fee and a portion of the revenues from selling offsets, or in exchange for a part of the carbon credits themselves (Adcock 2010). Before setting up the project, the PD needs to contact the state regulatory agency to ensure that the CAFO is in compliance with their permit. Once the project is set up, the PD hires a verifier to “verify” the project will do what it says it will do in terms of being a “green project” (such as ensuring the digester works) and to double-check the regulatory data gathered by the PD. The verifier then shares that information with offset registries (where offset projects

are listed for credits to be sold) and ARB to verify everything is correct one more time. Overall, it seems like a fairly exhaustive process, but the invalidation indicated that somewhere within this process there were gaps that led to an actively polluting project gaining credits.

It was at this point that I realized I needed to start talking to people within the invalidation process. After getting through IRB in the beginning of 2022, I started reaching out to potential respondents in the Spring of 2022. I reached out to potential respondents via email to request their participation in a short, hour-long interview over Zoom. My goal was to design the interviews in a way that did not seem overbearing or time consuming. I assumed many of the groups involved, particularly regulators such as the WDNR and ARB, already had enough work on their plates, so requesting a time consuming interview seemed like a sure way to have my email ignored. As a result, the interview design was quite straightforward. I chose to conduct semi-structured interviews that were based around 5-10 questions which varied depending on whether I was interviewing a regulator, project developer or verifier. My questions simply focused on what each actor does for their jobs and which other actors they communicate with to get that job done. I had the most questions for the WDNR because I was more familiar with CAFOs in Wisconsin and Wisconsin based regulations. For the Wisconsin regulators, the questions were:

- How is the WDNR involved in the invalidation process for methane offset credits?
- How is the invalidation process triggered?
- What is the general procedure for notifying ARB about violations that could result in invalidation of credits?
- How does the DNR handle the transition from offsets to LCFS on each AFO? What is the process like?
- How much do regulators at the WDNR like yourself interact with verifiers?
- How long does the verification process usually take on CAFO projects?
- I understand that verifiers use the EPA ECHO database to determine existing noncompliance issues. Do you know how much WDNR enforcement data is used during the verification process?

For the California regulators:

- Who are the different groups that are involved in the development of offset and LCFS projects on CAFOs?
- How often are regulators at CARB in contact with regulators at the WDNR?
- I understand that verifiers use the EPA ECHO database to determine existing noncompliance issues. Do you know how much WDNR enforcement data is used during the verification process?
- How often does CARB check in on offset or LCFS projects?
- What needs to happen for CARB to begin an investigation into invalidation of credits?
- Who first alerts CARB to these issues?
- How long does it take to first learn of a potential instance of invalidation?
- Have you ever been alerted about a potential invalidation only to have it not meet the standards of invalidation?
- How does a CAFO switch from offsets to LCFS?

For verifiers:

- Could you walk me through the initial process of verification for CAFO offset projects?
- Do you typically have any interactions with local regulatory agencies during the initial verification process? If so, please elaborate.
- Do you use any federal or state environmental enforcement data to verify projects? If so, please elaborate.
- I understand that there is some contention in the scientific community regarding the effectiveness of baseline emissions standards around methane. Could you discuss why this is an issue?

I began my research using a snowball sampling technique. The point for me was not to gather as many interviews as possible, but to identify strategic contacts. I was also not sure if any of the actors outside of the state (such as verifiers) would actually be willing to talk to me: a sociology PhD student who, upon a quick Google search, is clearly critical of the existing regulations around CAFOs.

On this note, over the course of my interviews and the process of reaching out to potential respondents, I experienced very different responses based on the group that I contacted. Regulators at both ARB and WDNR are typically quite busy and I was reaching out in the summer months when many people are out on vacation. Since this was the first time I conducted

interviews with top-level regulators, I was not assuming that I would actually be able to interview them. I was shocked when Regulator 1, who became my key contact for the rest of the department, responded to my request the same day. We had an interview set up within a week. They were extremely willing to share their experiences with me, particularly around their interactions with ARB and the invalidation against Central Sands. They told other regulators in the department that their interview with me was a “good experience” for them. This is when they began setting me up for interviews with four more regulators at the WDNR who primarily regulate large CAFOs. Out of the 5 regulators I interviewed at the WDNR, only 1 of them, Regulator 2, asked about my research focus in a short email exchange where they noted “That makes sense,” and went on their way (personal communication 2022). My point in elaborating on this exchange is to highlight that my research focus could have resulted in the respondents being less candid in their response. Either they did know I was critical of CAFOs and decided that was not an issue or never looked me up in the first place.

ARB responded very differently. I reached out to at least 10 employees from ARB over email. I chose two groups to reach out to: high level regulators and regulators who specifically worked within the invalidation division. Only two regulators responded. The first was from the invalidation division. However, they declined the interview request because their workload was too high at the time. I did not realize this, but it was during this period that ARB was working on yet another invalidation for Central Sands. The other forwarded my email to a manager within the offset credits program, but no one responded.

At this point, I was able to talk to many regulators from Wisconsin, but my perspective was limited when it came to actors outside of the state that work with these projects. To add that missing element, I used the ARB offset issuance table to identify verifiers and project developers

that worked on the CAFOs in WI with invalidations. For verifiers, that was 8 people. I had two verifiers that responded and were willing to discuss their experiences as verifiers. However, another verification body was more skeptical. The first time I reached out to them, they immediately declined because, “all my work is confidential in nature,” (personal communication 2022). When I replied, I aimed to ease their concerns about confidentiality by going through the ways I will make sure that no identifiable information outside of the basic functions of their job will need to be disclosed. This seemed to do something. Instead of ignoring the email, they requested to see the questions I was planning to ask because, “Our accreditation under ANAB has very specific rules and requirements about confidentiality (and our contracts do too,” (personal communication 2022). They also wanted to “see what you are after” before going forward with the interview. A few days later, they responded and declined my request for an interview. I found this interaction to be interesting considering the fact that verifiers, according to ARB, are supposed to be transparent with how they conduct the verification process.

Verifier 1 and Verifier 2 both had over a decade of experience within what they described as the “offset space” (personal communication 2022). Verifier 1 worked for an international verification body but spent a long period of time in the US verifying livestock projects. Verifier 2 also reviewed livestock projects but only within the US. Both of these verifiers were very willing to speak to me and both asked me about what my research area was and what my dissertation was about. They not only seemed to have no idea who I was, they did not seem to know what an environmental sociologist was. My qualifications must have been good enough because they both were interested in offering me a job (personal communication 2022).

The last group, project developers, were the least responsive to my inquiries. The developer that did respond made it clear that he knew I was interested in the “many very

controversial issues around dairies, CAFOs, carbon markets and carbon offsets,” (personal communication 2022). Specifically, they quoted a section of my biography from the Department of Sociology’s website. As a result, they wanted me to send my dissertation proposal to gauge “my perspective,” (personal communication 2022). Unsurprisingly, I did not hear from this developer again.

Before each interview, the regulators and verifiers were asked to read, ask questions, and sign a form that was designed to ensure they understood that their participation was purely voluntary, there were minimal risks, and we could stop any time they wanted to. I let them know that I would not use their names within the study. After receiving the signed consent forms, the respondents and I would talk for about an hour or so. I would then transcribe each interview using the AI transcription software “Wreally.” This software tool can save some time considering it offers a starting point that is not transcription from scratch. However, AI transcription services such as Wreally often misinterpret words when the respondents mumble or speak too quickly, which happened quite often during the interviews. After using the transcription software, I “cleaned up” the interviews by going through them a second time alongside the interview recordings to ensure they were correct. Then, I started analyzing the data.

The first step of my analysis was to create two documents, one for key verifier quotes and one for key regulator quotes. Then, I read through the interviews once more and began to pull out themes and I coded the data thematically. The regulators, understandably, had more Wisconsin specific themes related to state-level regulations and cases of invalidation that happened in the state. Verifiers gave more general information which was useful to understand what verifiers actually do in the real world.

Since Q2 was much different than Q1, I used a different range of data collection methods and sources. Specifically, I relied on process tracing using archival data to learn how digesters came about in the US. My goal here was to identify the key actors involved in the early digester projects and identify if the industry as it grew over time with the assistance of government sponsored scientific research. Unsurprisingly, my initial search on the history of digesters on farms in the US did not lead to much. CAFOs are specific enough. Trying to find existing histories on a niche technology *on CAFOs* was even more difficult. However, as I discussed in the research design section above, at this point, I already knew where to start: AgSTAR. AgSTAR is a federal program led by the EPA, USDA, and DoE. For the twentieth anniversary of AgSTAR, the EPA released a graphic identifying several key points within the history of the agency which is shown in figure 2.1 below. I used this timeline repeatedly as a way to situate my own timeline. In addition to this timeline, I found two sources outside of AgSTAR that were useful to get me started. The first was an archival document from the DoE, the Lusk report (1998). The Lusk report (1998) was a great place to start because it was the first document that gave an in depth history of digester research and development on CAFOs in the US. But a good rule of thumb is to never go by one source alone. I used articles from *BioCycle*, a journal for the recycling industry, to triangulate the information I found in the Lusk report.

Based on information I found in the Lusk report, I started looking for more details on the first “cases” of digesters by using the online archive service operated by the EPA, the National Service Center for Environmental Publications. It was here that I found copies of AgSTAR digest from 1998-2006. Each of these documents included a list of all the contemporary digester projects, including the successful projects from the AgSTAR Charter Farms which started in 1996. I used that list to identify new digesters, follow along with state-level trends within

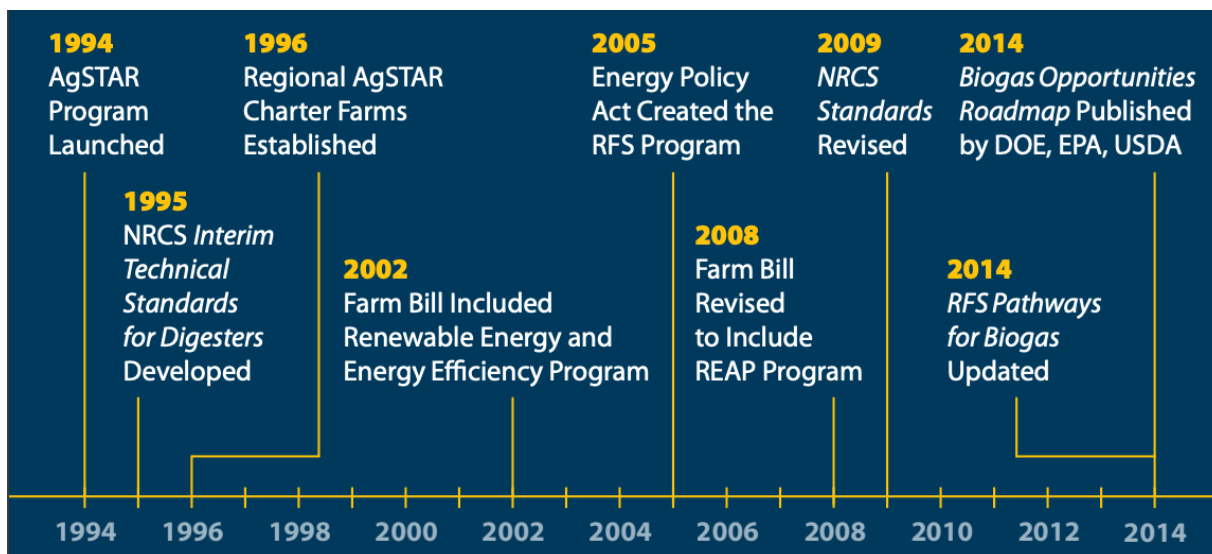


Figure 2.1: Timeline of important events in the history of AgSTAR (EPA 2014a)

Wisconsin, and add more detail to my timeline. Surprising to me, I found that my interview with Regulator 2 was extremely useful to trace the development of a digester industry in Wisconsin. Since I completed that interview before conducting this secondary research, I had already learned that Wisconsin's digester program was booming in the early to mid-2000s. And according to AgSTAR, it was much more successful than a similar program used in California. Because of this interview, I was finally able to start identifying what had driven digesters to flourish in Wisconsin much earlier than California as well as why many of those same CAFOs were switching to LCFS.

In comparative historical research, I find that my method of data collection and analysis happens almost simultaneously. I identified "key events" that several other actors within the field identified as a key event, placed them within the timeline, and described how those events fit within my theoretical framework of the nexus. Creating a timeline necessitated a large amount of back and forth between the data and the timeline, particularly because I was also tracing how the number of digesters changed in the US over time which corresponds to the size of the digester industry present on CAFOs in the US. By also incorporating the tracing of the number of digesters, I was able to observe periods of "booms and busts" within the digester market which I did not quite understand at the time, but eventually recognized as connected to even bigger trends within the industry such as the shift to the production of agrifuel.

Chapter 3: Polluting in Plain Sight: The Non-regulation of Agricultural Water Pollution in a Neoliberal State

Section 3.1: Introduction

Fifty years after the implementation of the Clean Water Act (CWA), it is clear that the US has not met the ambitious goals that Congress had initially hoped for. As highlighted by the Environmental Integrity Project (2022), across the US today, 55 percent of lakes, 50 percent of rivers and streams, and 25 percent of estuaries that were assessed by the EPA and state agencies are designated as impaired, meaning too polluted for people to use due to environmental degradation. The primary origin of pollution is neither the oil and gas industry nor the plastics industry but “runoff” from the agricultural industry. According to the EPA (2022a):

Polluted runoff is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into watersheds through lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water.

But what is in agricultural runoff that makes it toxic to the environment such that waterways become impaired? Manure contains useful nutrients for growing crops such as nitrogen, phosphorus, potassium (which is known as NPK in the fertilizer industry), and ammonia (Pagliari et al. 2019), but these useful nutrients can become an environmental problem if there is more waste than can be absorbed by the crops.

When used at the right time, in the right place, in the right amount, animal manure has proven to be an invaluable source of nutrients for growing crops for centuries. However, with CAFOs, “[w]hat once was a win-win situation—animal wastes fertilized the crops that fed the animals in a relatively ‘closed loop’ system with relatively insignificant pollution resulting—has

become a substantial environmental problem,” (Angelo and Hennes 2013: 38). Using data from the USDA’s 2017 Census of Agriculture, Food and Water Watch (2022) estimated that CAFOs produce over 442.5 million tons (or *885 billion pounds*) of manure annually. Due to the sheer volume of waste CAFOs are capable of producing, manure goes from a valuable resource to a liability for CAFO owners and a burden for the environment around the facility.

One of the most devastating ecological impacts of CAFO runoff from nutrients is called eutrophication (Rabalais et al. 2009; Smith, Joye, and Howarth 2006). When heightened levels of nitrogen and phosphorus enter surface waters such as streams, rivers, lakes, and bays, this causes microorganisms within the ecosystem such as algae to bloom at rapid rates. These “algal blooms” have the potential to cover entire lakes with a thick, green layer of algae. As they grow, algal blooms quickly deplete oxygen levels in the water and suffocate the marine life below. Algal blooms are known to produce “fish kills,” or events where large numbers of fish die simultaneously from hypoxia or lack of oxygen (Glibert 2020). Over time, hypoxic areas saturated with algal blooms become a “dead zone” because that body of water is unlivable for wildlife. The second largest dead zone in the world, covering over 6000 square miles, lies in the Gulf of Mexico (Howard 2019). The bulk of the nutrients that caused this pollution did not come from local sources, but agricultural runoff from the Corn Belt in the Midwest hundreds of miles away that flowed down the Mississippi River (Alexander et al. 2008).

Another body of water that has suffered immensely from nutrient pollution is the Chesapeake Bay (Chesapeake Bay Foundation 2022). Over the past 20 years, the state of Maryland has attempted to reduce the amount of nutrients in the bay by encouraging farmers to engage in “best management practices” by adopting what are known as nutrient management plans (NMPs). NMPs are used for CAFOs to determine the nutrient needs for their fields, how

much storage they need to properly store animal waste, and how much land available they have to spread on (Beegle 2003). However, whether the NMPs are not enough to limit pollution or farmers are not using them properly (as I discuss later in this chapter), ultimately these plans have only resulted in modest improvements and have not improved the overall quality of the Chesapeake Bay (Chesapeake Bay Foundation 2022).

The Chesapeake Bay is not only an important ecosystem, but also a place of immense cultural importance for local communities because it is the habitat of the blue crab. Indeed, the crab is prominently featured on the Maryland state flag and is the official “state food” as well (Paolisso 2007). Crabbing during the summer is a tradition for Marylanders and a central part of their state identity. This aspect of Maryland’s food culture makes the loss of the blue crab particularly devastating, not only for commercial fishing, but for the general population. Communities were shocked when reports emerged that the number of blue crabs in the Chesapeake had dropped to an all time low (Azhar 2022). Over the past five years, the number of blue crabs in the Chesapeake has been dropping sharply, from 600 million in 2018 to 227 million in 2022. Agricultural runoff is explicitly identified as a contributing factor to the rapid decline in blue crab populations, with as much as half the nutrients in the Chesapeake stemming from farms, most of them being CAFOs used for poultry production (Urbina 2008).

In this chapter, neoliberalism is about more than reducing the power of the state. With neoliberalization, the goal is to shift that state power over to the private sector and during the 1980s-1990s, that was exactly what the state did. Specifically, in this chapter, I trace deregulation and re-regulation (via privatization and marketization) of institutions that create and enforce the CWA in the US, primarily the EPA and the Wisconsin Department of Natural

Resources (WDNR), to show how these institutions built up the private sector at the expense of their own capacity to regulate water pollution.

Section 3.2: Neoliberalization of the US Environmental State

Scholars have argued for three decades that neoliberalism has profoundly reshaped the ways that states and corporations operate in the modern world. Thus without a discussion of neoliberalism, my analysis of environmental regulation would be incomplete. For Centeno and Cohen (2012), one way neoliberalism can be understood is as an economic doctrine that emerged after the perceived failure of Keynesian economic policies in the 1970s (Bonanno 2017). Neoliberalism is often framed as a return to *laissez-faire* economics, an economic doctrine and ideology that discourages any state regulation of the economy (Stahl 2018). Proponents of *laissez-faire* emphasize the utility of a self-regulating market which is, in theory, “completely decoupled from the coercive state and governed exclusively the free and equal exchange of goods by independent individuals,” (Stahl 2018: 480). Keynesian economics rose to prominence as a response to the social and economic devastation that resulted from the Great Depression and World War II (Farrell 2012). Keynesian economic theory encouraged an increase in state spending as a way to drive economic consumption, development, and economic growth. The influence of Keynesian economics in the US can be seen in, for example, policies that passed as a part of the New Deal. The basic assumptions of Keynesianism dramatically varied from those of *laissez faire* economics, which was a dominant form of economic theory before the 1920s.

Indeed, John Maynard Keynes, the namesake of Keynesian economics, heavily critiqued the key tenets of *laissez-faire* economics particularly in relation to the role of the state in the market economy. *Laissez-faire* stressed the importance of unregulated competition within

capitalism as a key driver of social progress, yet did so in a very one-sided way that disguises the existence of winners and losers. As Keynes (1926: 109) observed:

Economists, like other scientists, have chosen the hypothesis from which they set out and which they offer to beginners, because it is the simplest and not because it is the nearest to the facts... they assume[d] a state of affairs where the ideal distribution of productive resources can be brought about through individuals acting independently by the method of trial and error in such a way that those individuals who move in the right direction will destroy by competition those who move in the wrong direction... It is a method of bringing the most successful profit-makers to the top by a ruthless struggle for survival which selects the most efficient through the bankruptcy of the least efficient. It does not count the cost of the struggle, but only looks to the benefits of the final result, which are assumed to be permanent.

By the 1930s, the “cost of the struggle” was immense. It was not only the Great Depression that caused academics and politicians to challenge the logic of laissez-faire, but also the rise of fascism throughout Europe during periods of mass unemployment (Bonanno 2017). In these social and political conditions, a “hands off” state seemed undesirable.

After World War II, states became heavily involved in planning and enacting economic policy, eventually becoming what many scholars referred to as the “welfare state” (Esping-Anderson 1990). However, by the late 1960s, Keynesianism was losing legitimacy quickly as it failed to control a volatile economy (Block 1977). The late 1960s were characterized by a simultaneous decline in worker productivity and increase in trade deficits (Centeno and Cohen 2012). These conditions worsened in 1973 when the OPEC oil embargo, for the first time since World War II, caused a steady increase in inflation. Inflation rose at the same time that economic growth was slowing and unemployment was increasing which had devastating impacts on the US economy. It was this same year that the “Chilean experiment” began (Harvey 2005).

Harvey (2005) describes the roll out of neoliberalism as a “series of gyrations and chaotic experiments” (13) because it emerged as a political and economic experiment imposed on the

people of Chile in 1973. After Chile implemented trade liberalization, austerity, and other neoliberal policies, it experienced a period of growth to which neoliberal economists hailed as proof for their theories (Harvey 2005; Centeno and Cohen 2012). It was only after the ideological project to paint neoliberalism as the solution to problems of the state and economy was heavily underway that the Chilean economy became undone and slid back into crisis less than a decade later in 1982. At this point, however, the global economy was already on a path-dependent trajectory towards neoliberalization due to the election of key proponents of neoliberalism, Margret Thatcher in England and Ronald Reagan in the US.

Centeno and Cohen's (2012) second point was that neoliberalism can also be understood as an institutional strategy that attempts to control the many contradictions of capitalism using politics and political power. This aspect of neoliberalism is particularly useful for this dissertation considering one key feature of the neoliberal political project is the identification and deployment of different strategies that attempt to legitimate capitalism. At the same time, these strategies aim to minimize the negative effects that are caused by capitalism's inherent contradictions, such as the environmental impacts of climate change. In other words, the state remains essential to the function of capitalism despite drawing from ideas inspired by *laissez faire*. The way the state operates today deeply aligns with neoliberal goals and creates a state whose role is to, "[maintain] the neoliberal emphasis on regulating social and economic questions with market and quasi-market processes, but intervenes systemically on the supply-side in order to maximize efficiency gains," (Graefe 2007: 97). The state enacts these changes through neoliberal policy.

This active state role in neoliberalism is also recognized in Peck and Tickell's (2002) work. Their work is particularly useful to study neoliberal policy because of the temporal

element in their ideas of *roll-back* and *roll-out* neoliberalism. With this theory, what Peck and Tickell (2002) are really highlighting is neoliberalization. Neoliberalization emphasizes the importance of the process itself, variability in context, and the social relations surrounding these changes (Brenner, Peck, and Theodore 2010). Peck and Tickell observed that processes of neoliberalization in the Global North have followed a pattern of deregulation (the act of removing regulations and reducing the role of the state's enforcement capabilities) and re-regulation (the act of creating new regulations that favor the private sector and capital accumulation).

Critical geographers such as Peck and Tickell (2001) and Castree (2008) frame the 1980s as a period of widespread deregulation that they call “roll back” neoliberalism. Deregulation is the act of removing regulations and reducing the role of the state's enforcement capabilities (Aalbers 2016; Jessop 2002). Deregulation is the first step in the neoliberalization of the state. Deregulation is a central goal for proponents of neoliberalism because it is built on the *laissez faire* assumptions mentioned above, particularly that bureaucracies are inefficient and the state is a barrier to a properly functioning market. Thus the state should avoid intervention except when needed to remove barriers to capital accumulation (Peck 2010). The election of both Thatcher and Reagan² in 1980 ushered in a new era of neoliberal policy (Sellers et al. 2017).

Indeed, two days after his inauguration in 1980, US President Reagan formed a task force to enact his vision of a “New Federalism” called the Presidential Task Force on Regulatory Relief which specifically targeted regulations designed to protect worker health and the

² Although Reagan is often portrayed as the president that ushered in the era of neoliberalism, this is not entirely the case. In 1977, President Jimmy Carter paved the way for market-based environmental regulations by issuing an executive order that required agencies to find ways to limit their financial burdens on the private sector (Robertson 2016).

environment. One way to do that was by dramatically cutting taxes, a central source of revenue for the state (Kamlet, Mowery, and Su 1988). In 1981, the Economic Recovery Tax Act passed and cut income tax rates by 25 percent (Friedman 1992). Economists now know that these tax cuts had an undeniably negative impact on the economy. As highlighted by Friedman (1992: 300):

The Commerce Department's static analysis indicated that these payments would have been \$110 billion greater in 1984 and \$154 billion greater in 1986 (the last year before the tax code changed again) under the old rates. Even the most generous estimates of the positive revenue consequences of any induced "supply side" aspects of the 1983-1986 economic expansion do not approach these magnitudes.

In other words, these tax cuts left a massive gap in funding across the entire government. One important component of Reagan's tax cuts was the reduction of the EPA budget by a third.

By the late 1990s, many scholars theorized that the state had become powerless in the face of neoliberal globalization (Arrighi 1994; Koc 1994; Bonanno and Constance 2006). It was understandable considering they had just observed two decades of intense deregulation. Although the state was indeed being "hollowed out," it was simultaneously being built back up in neoliberalism's image. Peck and Tickell (2002) called this new period "roll-out" neoliberalism. Roll-out neoliberalism is characterized by a surge of neoliberal re-regulation which is, according to Castree (2008), "the deployment of state policies to facilitate privatization and marketization of ever-wider spheres of social and environmental life," (142). The introduction of re-regulation in addition to deregulation indicated to scholars that:

...the appropriate analytical question to ask, in instances of neoliberal 'downloading' of policy responsibilities, is not the extent to which the national state has somehow become 'less' powerful in the process, but how it has become differently powerful. Hence the need to see 'hollowing out' as a qualitative process of state restructuring, not as a quantitative process of state erosion or diminution (Peck 2001: 447).

With neoliberalization, states were not losing power, but rearranging their power in ways that gave specific advantages to the private sector.

Privatization is foundational to the neoliberal project because it involves a transformation of social, economic, and legal relations through the transfer of ownership rights from the public to the private sector. Scholars that focus on the first dimension of privatization commonly utilize the concept of accumulation by dispossession (ABD) (Harvey 2003), which is drawn from Marx's theory of primitive accumulation (Marx 1977), to theorize about the role of neoliberalism in the privatization of common resources. Primitive accumulation describes, "the historical premise to the capitalist mode of production and therefore focuses on the process of separation between people and means of production in the moment of transition between modes of production," (De Angelis 2001: 2-3). As opposed to Adam Smith's abstracted notion of primitive accumulation, Marx's materialist approach underscored the specific and brutal historical processes that encompassed the process of primitive accumulation. Indeed, Marx explicitly noted that, "capital comes dripping from head to toe, from every pore, with blood and dirt," (Marx 1977: 926) These underlying processes of capitalism such as slavery, colonialism, and imperialism were instrumental for the establishment of the capitalist system.

However, Harvey (2003) frames the concept of ABD as distinct from primitive accumulation because the term "primitive" suggests they were processes relegated to the past when they are, in fact, ongoing. These processes of dispossession of common natural resources not only continue, but involve a new set of institutional actors in international finance (Gellert 2015). Throughout the process of ABD today, "finance capital and the credit system have been major levers of dispossession, while the states, with their monopolies of violence and definitions of legality have been crucial protagonists," (Arrighi 2004: 531). Indeed, the arguments used to

justify contemporary forms of ABD are deeply rooted in neoliberal logic. While ABD can be utilized by state actors within their own borders, Harvey notes that processes of ABD become difficult to enact as states become more developed and as a result spreads globally. However, in the neoliberal era, states in the Global North have found new resources to privatize and spaces to enclose (Robbins and Luginbuhl 2007; McCarthy 2007).

Here, I find it very useful to draw from scholarship within critical geography, specifically the “neoliberal natures” literature (Heynen et al. 2007). One key focus of this literature is the privatization of state functions. The privatization of water governance was a central theme because several states across the world system have privatized key public services for water and sewage management since the 1990s. However, since the focus of my dissertation is Wisconsin, I find it useful to draw from scholars who highlighted instances of privatization in the Global North. For example, in a case study of privatization in England and Wales, Bakker (2007) highlights that the governments of England and Wales were the primary proponent of privatization of public water and sewage services. This enabled a small number of large firms to dominate the state’s water infrastructure and the price of water rose dramatically as a result. Privatization of public water resources disproportionately impacted low income communities who eventually became unable to pay for the cost of this newly privatized, yet essential, resource. It was not until the election of Tony Blair in 1997 that price caps were implemented to protect consumers from the side effects of privatization.

Another case study that is highly useful for this dissertation is Prudham (2007)’s study of the town of Walkerton, Ontario. In this case, Prudham focuses on the impacts that followed after officials in Ontario, Canada privatized their water management system via neoliberal reforms in 1995. By 2000, management of 80 percent of municipal water systems in Ontario were shifted to

private managers. This system came under scrutiny when water managers in Walkerton, Ontario failed to detect the presence of a dangerous strain of *E. coli* in local sources of drinking water stemming from agricultural runoff from a dairy farm. According to researchers at the US Institute of Medicine (Hrudey and Hrudey 2019):

On Monday, May 22, the first victim of the outbreak, a 66-year-old woman, died. Subsequently, a 2-year-old child who visited Walkerton on Mother's Day (May 14) and consumed only one glass of water, died on Tuesday, May 23. Ultimately, 5 more deaths to total 7, 27 cases (with a median age of 4) of HUS, a life-threatening kidney condition that may subsequently require kidney transplantation, and 2,300 cases of gastrointestinal illness were attributed to consuming Walkerton water.

The operators of the water system not only falsified records, but ignored other utility managers who tried to warn them that the pollution levels in their water were dangerously high. Although the state of Ontario immediately blamed the incident on the actions of the operators, Prudham claimed this response did not address how the state encouraged the development of a regulatory system with weak oversight, thus enabling local incompetence and heightened risk of instances of contamination. This form of re-regulation in conjunction with the deregulation/ re-regulation of livestock farms via Right to Farm laws in 1995 created a system in which the Walkerton tragedy was not a case of bad actors, but the outcome of the implementation of neoliberal reforms that enabled these actors to occupy these positions in the state regulatory structure.

The second form of re-regulation I focus on in this dissertation, which is often used in conjunction with privatization, is marketization. While privatization alters the power of the state by fully transferring certain regulatory tasks and powers to the private sector, marketization operates differently in that it encourages the state itself to act like a market (Carroll 2012). For Birch and Siemiatycki (2016), marketization, “involves the introduction of markets and market forces into the state, primarily into its functioning, authority and legitimation,” (179). A

marketized state assumes that the best mechanism for curbing environmental problems is in the form of “soft” regulation such as voluntary, market-based, and self-reported regulation as well as public-private partnerships (Shamir 2010). With marketization, the state still has some control over regulatory capabilities rather than fully turning them over to the private sector. The key difference here is *ownership*. Instead of being replaced by a market, marketization pushes states to create and become *a part* of those new markets themselves. A useful way to decipher between privatization and marketization is to ask, *who is paying whom?* With privatization, state functions are completely brought outside of the state and maintained, paid for, and operated by the private sector. With marketization, however, these entities are still paid by the state with many of these relationships lasting long periods of time (Birch and Siemiatycki 2016).

Marketization also contains discursive elements that prioritize “efficiency” and “value for money” (Birch and Siemiatycki 2016). Efficiency discourse is connected directly to the logic of neoliberalism, which assumes that the market, not the state, is the most efficient way to deliver services to “citizen-customers.” When value for money discourse becomes a key part of policy, the state prioritizes “targets, competitions, and cost” on all policies which makes the state “receptive to private sector participation,” (Rutherford 2003: 45). These policy discourses encourage, “particular forms of governance, especially those involving new (long-term) contractual arrangements like public-private partnerships (PPPs),” (Birch and Siemiatycki 2016: 188). Value for money discourse, as I discuss below, has become a central component of neoliberal policy since the Reagan Administration in the 1980s.

PPPs are programs or policies that encourage the public sector and private sector to work together as a part of the regulatory state. As noted above, PPPs are distinct from practices like outsourcing because they involve long term contracts which transfer power to regulate public

services to the private sector who then take over the practice of creating, running, and managing infrastructure or state services. Another important dimension of PPPs as an instrument of marketization is their capacity to enable the creation of not just one market, but multiple markets. By encouraging PPPs, the state legitimates the normalization of the private sector in regulatory spaces (with an added bonus of avoiding politicized language such as “privatization” or “outsourcing”) while simultaneously creating deep “state-market entanglements,” (Hodge and Greve 2009; 2010). Although Birch and Siemiatycki (2016) provide many useful examples of marketization in the UK, connections to how marketization “rolled out” in the US were sparse.

Marketization was a central strategy in the neoliberalization of environmental regulations in the US. It added new requirements that encouraged regulatory agencies to “think like a business.” But before discussing how the Reagan administration enacted these strategies within the EPA, we need to consider the downsides of encouraging the state to think like a business in relation to environmental problems. How do businesses think about managing the pollution they create? One central issue is that businesses often *do not* manage their pollution and instead rely on externalizing it to the environment around them. This preference for externalization is characteristic of industrial agriculture in the US (Buttel 2003). Industrial agriculture has historically sought to operate within “frontier” economies which are characterized by vast amounts of space to use for cheap waste disposal and weak regulations to enforce pollution standards (Princen 2002).

Indeed, in their analysis of the external costs of surface water pollution from CAFO runoff in Wisconsin, Raff and Mayer (2021) found that adding just one CAFO to a region increased phosphorus levels in local bodies of water by 1.7 percent and ammonia levels by 2.7 percent. Drawing from longitudinal data from across the entire state of Wisconsin, they

estimated that a “marginal” CAFO is capable of producing (at least) \$203,541 worth of damages to surface water per year (Raff and Mayer 2021). Indeed, costs related to remediating just the pollution from surface water could cost the average CAFO between 4-18 percent of their annual sales revenue.

In their study, Raff and Mayer (2021) used cost-benefit analysis, which has become a standard practice in environmental regulation. In 1981, Reagan signed executive order (E.O.) 12291 which, for the first time, required that every major regulation put forward by federal regulatory agencies, including the EPA, was subjected to a cost-benefit analysis to be overseen by the Office of Management and Budget (OMB). This re-regulation subjected the EPA to a new set of requirements at the same time that their budgets were dramatically reduced. According to Sellers et al. (2017), E.O. 1229, “gave unparalleled control over environmental rulemaking to the OMB, an office whose lack of transparency made it especially open to business influence,” (11).

Cost-benefit analysis, also called Regulatory Impact Analysis (RIA), in practice, had serious implications for environmental regulation since the remediation of environmental problems have unknown and difficult to accurately assess costs and benefits (Whittington and Grubb 1984; Buttel 2003; Ackerman and Heinzerling 2002). Cost-benefit analysis is a key form of marketization in the realm of environmental regulations. According to Ackerman and Heinzerling (2002:):

Development of environmental regulations has almost always involved consideration of economic costs, with or without formal cost-benefit techniques. What is unique to cost-benefit analysis, and far more problematic, is the other side of the balance, the monetary valuation of the benefits of life, health, and nature itself. Since there are no natural prices for a healthy environment, cost-benefit analysis requires the creation of artificial ones. This is the hardest part of the process.

Cost-benefit analysis assumes that costs and benefits can be reduced to a monetary value when that is often not the case. The most common way to calculate the “cost” of an environmental problem is simply to ask people what they would be willing to pay to fix an environmental problem or to enjoy the benefits of a non-polluted place which contradicts the basic principles of the Environmental Justice movement

In practice, cost-benefit analysis has serious limitations for the regulation of the environment. In their analysis of existing cost-benefit analyses, Whittington and Grubb (1984) discovered that these evaluations had glaring issues. Despite the fact that the regulation required RIAs to include “alternative approaches that could substantially achieve the same regulatory goal at lower cost,” (E.O. 12291 1981), analysis revealed that, “...many of the RIAs performed to date fail to consider clear alternatives. In particular, they ignore alternatives that might meet regulatory goals more effectively but would require more stringent regulations or higher costs to firms,” (65). Additionally, the actual documents used to evaluate costs and benefits disproportionately focused on the increased benefits of deregulation for corporations while simultaneously ignoring how deregulation can decrease benefits for workers, the environment, and communities in general. Indeed, Whittington and Grubb (1984) were correct to ask “Beneficial for who?” when evaluating these new regulatory standards. RIA reports were not required to mention how costs and benefits were distributed across groups even when the “winners and losers” in these cases could be clearly identified.

The EPA was further subjected to market-based requirements in 1985 with the passage of the Gramm–Rudman–Hollings Balanced Budget Act (BBA) (EPA 1989). This piece of legislation, another first of its kind, implemented binding constraints on any spending by the federal government as a way to discourage “fiscal irresponsibility” by what the Reagan

administration and much of Congress saw as an inefficient and bloated bureaucracy (Quayle 1988). However, the BBA was challenged and struck down as unconstitutional by the Supreme Court within a year. For the first time since 1935, the Court struck down a federal law on the basis that it was an “improper delegation of legislative power” (Young 1986: 8). With some tweaking, a new version of the BBA which still contained the key parts of the old BBA, was passed and enacted in 1987.

It was after the BBA was enacted and they faced more severe budget cuts that the EPA began entertaining PPPs. Indeed, within only two years, the EPA had completed their guidelines for promoting PPPs, or what they called P³ (EPA 1989). If one thing was clear from the EPA’s initial guidance documents for PPPs (see figure 3.1), it was that the EPA did not necessarily make the choice to embrace PPPs on their own, but were forced to as a result of budget constraints. The EPA states specifically in these guidelines that, “The new state of affairs reflected in legislation such as the Gramm-Rudman-Hollings bill means we can no longer rely on the Federal Purse to pay for as great of a share of environmental protection as it has in the past,” (EPA 1989: 1). But at the same time, the EPA, along with other regulatory agencies, were scrambling to figure out how to fulfill their regulatory obligations with only a portion of the budget. As a result, the EPA turned to “creative solutions” (2).

The creative solutions they chose were, in effect, privatization and marketization. In fact, in this report, the EPA created a graphic that I find surprisingly useful to differentiate between privatization and marketization (figure 3.2). As opposed to Birch and Siemiatycki (2016) who explicitly frame PPPs in the context of marketization, the EPA views both privatization and marketization (such as contract services) as forms of public/private partnerships. However, the

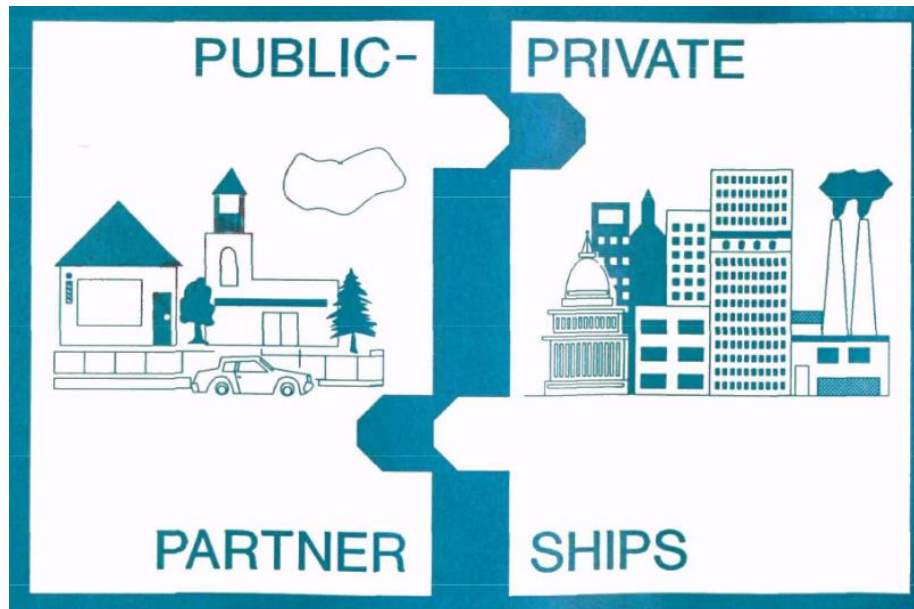


Figure 3.1: Image used on the cover of the EPA's (1989) guidebook on public/private partnerships.

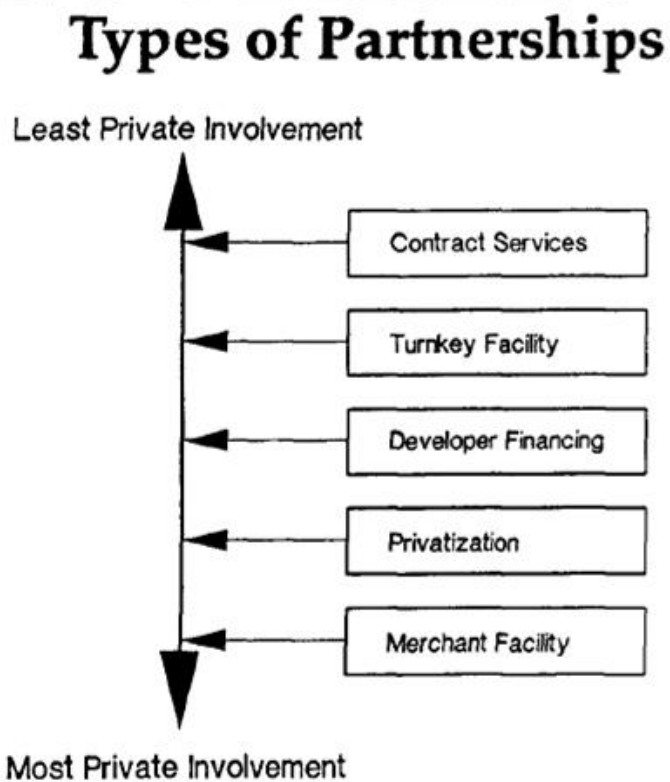


Figure 3.2: Types of PPPs ranging from most privatized to least privatized (EPA 1989)

theoretical distinction between them is still intact: privatization involves less state and more private involvement than marketization. In addition to PPPs, the EPA also encouraged several practices including: 1) technology transfer (training the private sector to directly take over infrastructure related to environmental management), 2) technology development (developing technology for use in the private sector), and 3) legislative/ regulatory flexibility in the implementation and enforcement of environmental regulations (EPA 1989). Overall, the private sector was encouraged to start taking an active role in environmental enforcement and become a “partner in the delivery of environmental services” (16).

Up until this point, I have highlighted how throughout the 1980s, the regulatory capabilities of the EPA were slashed and gave the EPA a new, neoliberal direction. For the rest of this chapter, I discuss the current state of CAFO regulation in the US and Wisconsin. At the same time the EPA’s regulatory power was stunted and they were encouraged to empower the private sector, the number of CAFOs began to rise sharply in the US. With the neoliberalization of the state, industry has grown at the same time the state shrunk. Three decades later, in the era of climate change, entangled states and markets are struggling to control the pollution and environmental problems that resulted from the deregulation, privatization, and marketization of the state. However, as I will discuss in the next chapter, increased environmental degradation has not stopped the state from creating new, “green” markets.

Section 3.3: The Rhythms of Re-regulation: EPA, CAFOs, and the Weakness of Contemporary Regulations under the Clean Water Act

In 2022, the CWA, which is the central piece of legislation governing water pollution in the United States, turned 50 years old. When it was passed in 1972, the ambitious goal of the

CWA was to, “to eliminate the discharge of all pollutants into the waters of the United States by 1985,” (33 U.S.C. § 1251 1972). The passage of the CWA reshaped environmental regulation by creating a national reporting system, called the *National Pollution Discharge Elimination System* (NPDES) for “point sources” of industrial pollution as a way to track and monitor the substances that were discharged into waters of the US. The CWA defines point sources as (EPA 2022a emphasis added):

...any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, *concentrated animal feeding operation*, or vessel or other floating craft, from which pollutants are or may be discharged.

Once a facility is designated a point-source, the CWA gives the US Environmental Protection Agency (EPA) the authority to require an NPDES permit. Data collected for an NPDES permit include: 1) the number and type of animals on site, 2) the topography of the site where the CAFO is located, 3) the location of manure lagoons and storage areas, 4) an estimation of the amount of manure the CAFO will produce, and 5) a nutrient management plan (NMP) (EPA 2017). The key roles of the EPA as a national agency are to develop, implement, and enforce environmental regulations as well as to conduct and sponsor research to identify, track, and assess environmental risks (EPA 2022b).

From the beginning of the creation of the NPDES, the EPA has used its powers under the CWA to also authorize individual states to carry out the bulk of approval, implementation, monitoring, and enforcement of NPDES permits (EPA 2022c). States regulating NPDES permits use federal regulations as a baseline but can also build their own. The original definition of point-source used by the CWA is interesting in that CAFOs are the only industrial facility explicitly named as a source of point source pollution (Kenyon 2017). Here, we can see that at

the time the CWA was formed, Congress clearly differentiated between a farm and a CAFO. This is understandable considering CAFOs were still a relatively small percentage of all farms at the time. Indeed, in my search of the publicly available data on the USDA's National Agricultural Statistics Service (NASS), I found that the earliest year they started collecting national data on the number of CAFOs in the US was 1982, a decade after the CWA was passed. By that time, there were 3,594 large CAFOs in the US across all types of livestock (Government Accountability Office 2008). By 2002, the number of CAFOs in the US had risen by 234 percent to 11,995.

NPDES permits were designed to track and regulate this massive quantity of manure on the farm, but that changed in 1987 (Kenyon 2017). The changes made by Congress to CAFO regulation in 1987 severely undermined the ability of states and the EPA to regulate CAFOs by exempting agricultural runoff from the definition of point source pollution. But what does this mean? According to Congress' new interpretation of the CWA, CAFOs went from point sources, to both point sources and "nonpoint" sources of pollution, which is not regulated by the CWA. This decision meant that agricultural runoff was no longer regulated by the CWA. According to the new regulations, once runoff migrates from the farm due to rainfall or snowmelt, that pollution does not need to be regulated despite the known social and environmental harms. Since that time, the only practice put in place to minimize runoff are NMPs. It would not be an exaggeration to say that almost every state relies exclusively on NMPs, which have been heavily privatized since the 1990s, to manage agricultural runoff (Hall and Essman 2019). These plans are not only voluntary for any CAFO that falls under an arbitrarily decided threshold, but self regulated as well.

As CAFO regulations exist in the US today, regulators are legally required to assume that CAFOs will not leak waste into the environment until they reach a certain size OR the state proves, typically based on the complaints of neighbors, that they are actively polluting (Kenyon 2017). The lack of regulatory oversight within the meat and dairy sector has encouraged CAFO owners and operators to find creative ways to skirt regulations that would result in them becoming subject to more stringent regulatory standards. Indeed, the University of Colorado Extension Services provided guides to farmers on “How to Avoid CAFO Status” (Food and Water Watch v. EPA 2017). Ultimately, this means that unless a CAFO is caught polluting, both states and the EPA have no clue how many CAFOs are in their state, where they are located, and if they are polluting or not (Miller and Muren 2019; McVan 2022). The EPA has always had the power to clarify these ambiguous regulations and clearly define CAFOs as point sources considering the exemption of agricultural runoff was never a part of the CWA and the legislative history that existed to support the exemption was “sparse” and “unhelpful” (Kenyon 2017; 1215). However, despite many challenges from environmental groups in the 36 years between the runoff exemption becoming law, the EPA has explicitly chosen to side with industry groups and stay silent even in the face of growing pollution issues and claims of environmental injustice.

In this section, I examine how the EPA has avoided using its powers under the CWA to regulate CAFOs over the last 50 years. Since the CWA was created just short of a decade before the Reagan administration, I can observe how the state implemented the CWA before and after the rise of neoliberalism. Analysis of the legal history of CAFOs not only highlights that the existing regulations under the CWA are weak, but the EPA has done little to strengthen them despite their immense environmental impact on waters of the US. The first challenge came in 1977 with environmental groups objecting to the ineffectiveness of NPDES permits. Groups

such as the Sierra Club and the Natural Resources Defense Council (NRDC) claimed that these regulations did not go far enough to protect waters from agricultural runoff stemming from industrial sources (NRDC, v. Costle 1977). In response, the EPA created two new regulations for agricultural runoff, one for CAFOs and one for agricultural activity in general (Kenyon 2017). The EPA chose to exempt various agricultural activities from permitting requirements, but spreading manure around CAFOs was not one of them. In the EPA's reasoning at the time, CAFOs as they existed were already producing substantial amounts of waste, thus should clearly be identified as point sources.

The way the CWA regulated CAFOs changed dramatically in 1987 when Congress exempted agricultural stormwater runoff from the CWA. In many ways, this move reduced the ability of the state to regulate pollution from CAFOs because it was incredibly difficult to tell if their pollution was point source (thus regulated) or nonpoint source (thus unregulated). What this change did was introduce an immense amount of legal uncertainty into the basic definition of CAFOs and instead of clarifying these issues, the EPA did nothing. According to Kenyon (2017: 1197):

No other changes were made to the statutory definition and CAFOs were still included within the definition. Given their classification as a point source, it was unclear whether CAFOs were eligible for this exemption. Some stakeholders concluded that CAFOs were exempt from NPDES permitting requirements altogether if precipitation caused the discharge, while others believed CAFOs were never eligible for the exemption. The limited legislative history exacerbated confusion.

By 1991, the amended EPA regulations were challenged by the NRDC (NRDC v. US EPA 1992). Following this challenge, in 1992, the EPA was ordered to strengthen regulations for nonpoint source pollutants. It took the EPA 11 years to create the regulations that would eventually become known as the "CAFO rule" in 2003 (Centner 2011). By the time these more

concise regulations for CAFOs were released by the EPA in 2003, the number of CAFOs in the US had risen dramatically. Between 1992 and 2002, the number of US dairy farms with herds larger than 999 animal units had risen from 9 percent of farms, to 28.8 percent of farms (MacDonald et al. 2020). During this growth period, there was a lack of regulatory guidance for large farms.

The 2003 CAFO rule finally offered some clarification to these ambiguities. The EPA ultimately decided to allow agricultural runoff to be exempt from the CWA, but only, “precipitation-related discharge of manure, litter or process wastewater from land areas under the control of a CAFO,” (40 C.F.R. § 122.23[e] 2003; quote found in Kenyon 2017). In other words, as long as the discharge was runoff from fields related to a weather event and the CAFO had an approved NMP, this pollution was unregulated. However, because CAFOs are explicitly named in the definition of point sources, the EPA reasoned that this was meant to apply only to the production site of the CAFO itself, not the fields around the CAFO where waste is dumped onto the ground, sprayed into the air, and pumped into the ground. The 2003 CAFO rule was also the first to introduce the concept of “duty to apply” for an NPDES permit (Kenyon 2017). With this new rule, the responsibility was on CAFOs, not the EPA or state agencies, to prove to regulators that there was “no potential to discharge.” If they could not, they had to apply for a permit. If they were caught without that permit, the penalties would be higher. Industry groups applauded the EPA’s decision to allow the stormwater exemption, but immediately challenged the duty to apply. Luckily for industry groups, duty to apply was vacated by the Second Circuit by 2004.

Environmental groups were not pleased with either of these decisions. Less than a year after these new regulations were released, the EPA was challenged in the 2004 *Waterkeeper Alliance* case, arguably the most important recent case for the establishment of regulations of

CAFOs. This case was brought by Waterkeeper Alliance, the NRDC, Sierra Club, and the American Littoral Society and explicitly challenged the new CAFO rule as inadequate. The Second Circuit of the US Court of Appeals agreed, highlighting in their findings (Waterkeeper Alliance Inc. v. United States Environmental Protection Agency 2005):

As presently constituted, the CAFO Rule does nothing to ensure that each Large CAFO has, in fact, developed a nutrient management plan that satisfies the above requirements. The CAFO Rule does nothing to ensure, in other words, that each Large CAFO will comply with all applicable effluent limitations and standards. This is because, most glaringly, the CAFO Rule fails to require that permitting authorities review the nutrient management plans developed by Large CAFOs before issuing a permit that authorizes land application discharges.

The Court sided with the plaintiffs and, for the third time in a little over a decade, the EPA was ordered to strengthen the regulations in order to meet the basic requirements of the CWA. The latest revisions of the CAFO rule were released in 2008.

The 2008 CAFO rule widened the scope of farms that were subject to regulation under the CWA. Originally, only farms that discharged pollution into waters of the US were required to acquire an NPDES permit. However, the 2008 CAFO rule made three key changes to the regulation. These included: 1) a duty to apply, 2) a penalty for failing to apply, and 3) NMPs became a requirement within the NPDES permitting process. In addition to bringing back duty to apply, the EPA added another component: “proposing to discharge.” If a CAFO had a proposal to discharge that meant that they were, “designed, constructed, operated, or maintained such that a discharge will occur,” (Bleshman 2011: 210). The new component reinterpreted the definition of CAFOs to accommodate the growing body of evidence that showed that if managed improperly, CAFOs acknowledge discharge into the environment regardless of whether they intend to or not (Buttel 2003; Burkholder et al. 2007; Mallin and Cahoon 2003).

The broad discretion that the EPA asserted in the 2008 CAFO rule horrified the livestock industry. As I discussed above, one reason these industries were quick to fight increased regulation is because they rely on externalization of pollution to the environment as a cheap way to get rid of waste (Buttel 2003; Burkholder et al. 2007; Gunderson 2011). Proper waste management is not only more work for the CAFOs, but more expensive. More demands on waste management means increased costs related to technology and the costs associated with complying with regulations. For example, according to the National Agricultural Law Center, fees for a crop consultant to create an NMP can cost between \$2,400 to \$12,100 (Hall and Essman 2019). There are also the costs of not complying with regulations. Farms found to be emitting pollutants without a permit under this new CAFO rule, as was suggested by the EPA in their letter to Perdue executives, could be subject to fines ranging from \$50,000-\$100,000 per day (National Pork Producers Council v. EPA 2011).

Shortly after the implementation of the 2008 CAFO rule, the rule was challenged (National Pork Producers Council v. EPA 2011). The National Pork Producers Council was joined by the Dairy Business Association, which has been instrumental in creating pro-CAFO policy in Wisconsin, the National Milk Producers Federation, and the North Carolina Pork Producers Council in conjunction with United Egg Producers, the National Chicken Council, the US Poultry and Egg Association, and the Farm Bureau, who wrote the court brief for the “farm petitioners.” Ultimately, the farm petitioners’ challenge was successful in two ways. First, the court ruled in favor of the agribusiness groups that challenged the duty to apply requirements of the 2008 CAFO rule. In this case, according to the court, the EPA did not have the authority to create such a sweeping rule with broad implications. As a result, regulators, environmental

groups, lawyers representing rural communities and the communities themselves have been left on their own to figure out these confusing regulations.

In 2017, Food and Water Watch along with dozens of rural justice and environmental justice groups across 13 different states, including Wisconsin, filed a rulemaking petition with the EPA detailing the extent of CAFO pollution in the US and encouraging the EPA to reconsider their lax regulation of nonpoint source pollution (Food and Water Watch 2022). In this scathing legal petition, the petitioners presented ample evidence to support their position that the EPA had no interest in strengthening regulations for the livestock industry, especially CAFOs (Food and Water Watch v. EPA 2017). They alleged that during the entire time the EPA was in court over the last two decades, the agency had never once presented the argument that CAFOs should be *presumed* to discharge. In the *Waterkeeper* decision, the court noted that the, “EPA had not argued that the administrative record in that case ‘support[ed] a regulatory presumption to the effect that Large CAFOs actually discharge,’” (Waterkeeper Alliance v. EPA 2005 found in Food and Water Watch v. EPA 2017). The petition alleges that the EPA failed to use their own powers to establish that CAFOs routinely discharge in inadvertent ways to the environment due to their scale. Despite the court in the *Waterkeeper* case suggesting that the EPA use the evidence they had at their disposal to establish an evidentiary presumption that fields around CAFOs, at a certain point, *become* sources of point-source pollution, *the EPA chose not to do so*. Not only in this case, but also in the case of the *National Pork Producers Council*.

Unfortunately, the regulation of air pollutants around CAFOs is even more de/reregulated than water pollution, even during the era of climate change. As a result of the *Waterkeeper* case in 2004, the EPA was ordered to strengthen existing air and water regulations around CAFOs. Instead of strengthening air regulations for CAFOs the EPA and the National Pork Producers

Council (NPPC) entered into a consent agreement, known as the “Air Consent Agreement” that favored the livestock industry (Jones et al. 2017). The EPA and the NPPC came to the agreement that the EPA would not sue producers that use CAFOs for violations of the Clean Air Act (CAA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) if they paid a fee (\$2500) to fund a program that measured and monitored air emissions from CAFOs called the National Air Emissions Monitoring Study (NAEMS).

The NAEMS is yet another example of the neoliberal state/science/industry nexus in action. As noted by Office of the Inspector General after an investigation of the program in 2017, “According to the NAEMS Science Advisor, the NAEMS protocol could be viewed as a compromise between compliance-minded EPA, budget-minded industry, and publication-minded universities,” (Jones et al. 2017: 15). This “compromise,” which could also be viewed as a PPP (a form of marketization and privatization), was led by the EPA, university scientists (mostly from land grant universities), and the Agricultural Air Research Council (AARC)— a nonprofit organization created by industry. The AARC was not only tasked with managing the funds for the NAEMS, but they were also in charge of selecting the leadership, design, and oversight of the study.

A central goal of the NAEMS was to develop emissions estimating methodologies based on studies of existing CAFOs for industry use later on to measure their own emissions. Scientists from industry, academia, and regulatory agencies agreed that the best way to carry out this study would be to collect large amounts of detailed data from a handful of sites as the basis for these methodologies instead of collecting a small amount of data from many sites. According to the Inspector General’s report, the EPA noted that the central reason for this selection was cost-effectiveness (Jones et al. 2017: 15).

It would not be hyperbolic to describe the NAEMS as an abject failure. This study was supposed to be completed by 2010, but *remains incomplete over a decade later*. Despite never releasing any of the information that was gleaned from the research conducted on CAFOs, the Air Consent Agreement is still in place, meaning CAFOs are *still not required to report their GHG emissions to the EPA* even if they release air pollutants that exceed the limits of the CAA (Jones et al. 2017). This means that CAFOs have not been required to measure or report their emissions to the EPA for the last 18 years. Indeed, although the EPA produced various reports of emissions and sinks, the data they use are either handed over voluntarily by CAFOs or they are based on generalized estimates (EPA 2023). Because the EPA does not know the total number of CAFOs in the US and where they are located, it can be assumed that the actual amount of emissions produced by agriculture is much higher than 11 percent. Digesters are incredibly valuable to the industry because they are a part of voluntary and/or marketized programs, and also give CAFOs legitimacy amidst claims that the industry is not only contributing to climate change, but contributing harm to rural communities across the US

The EPA, as a public regulatory agency, is required to respond to legal petitions of this scale. Yet the EPA never responded. In October of 2022, Food and Water Watch sued the EPA, alleging that the EPA violated the Administrative Procedure Act (APA) by failing to make any attempt to address the petitioner's concerns for over 5 years. The EPA was eventually forced to respond and did so by January 2023. Based on this pressure from environmental justice and food justice organizations (Food and Water Watch 2023):

EPA recognized that the factory farm pollution data it had been relying on to determine whether its regulations were effective were “sparse” and inadequate. The agency plans to gather detailed information about factory farm wastewater discharges to rectify this data gap. EPA also admitted to lacking sufficient understanding of pollution control technologies and practices that may have developed since its 2003 and 2008 CAFO rulemakings. It has therefore agreed to engage in a comprehensive technology review.

Currently, it is unclear if these efforts will result in any meaningful changes to agricultural practices due to political pressure from agricultural interests.

While going through these cases, it became clear that in the legal history of the EPA and CAFOs, the EPA has chosen a side. For agricultural trade groups like the American Farm Bureau Federation (AFBF), whenever a new regulation is proposed, they immediately go on the attack. Currently, the AFBF is the largest farmer organization in the US with almost 6 million members (AFBF 2023). To put this number in perspective, in 2021, only 2.6 million people were farmers (USDA 2022). The bulk of their membership is not made of farmers, but anyone who signs up to become a member of the AFBF (Shearn 2012). In other words, since the 1950s, the AFBF has become more than a trade organization, while that remains a large focus of their mission. It has become a multi-billion dollar insurance company, a cornerstone of rural politics, and an immensely powerful source of political support for agricultural practices that encourage appropriationism and substitutionism. As highlighted by Shern (2012):

In rural areas, the Farm Bureau grooms compliant political candidates, mostly Republicans; it wields the power to dictate outcomes of legislative elections and appointments to powerful state agriculture committees. Then it influences which farm-related bills become law. Along the way, it has become a close second to Monsanto in lobby expenditures for agriculture-related issues, spending nearly \$6 million in 2011 — all in the name of “farmers.”

Indeed, the AFBF’s name can be found amongst the most powerful corporations in agribusiness today with the AFBF owning large quantities of stock in Tyson, ConAgra, DuPont, Cargill, and Archer Daniels Midland.

One phrase AFBF is particularly fond of in this context is “regulatory uncertainty,” (AFBF 2017). Here, farm groups like the AFBF, National Pork Producers Council, and so on

will lobby representatives against implementing any new regulations at all because they create “confusion and uncertainty” for farmers. However, my analysis of the legal history of CAFOs suggests that they thrive on legal uncertainty for environmental groups. In 1987, the agricultural industry, particularly livestock farmers, experienced a huge win when CAFO stormwater runoff was exempt from regulations. For environmental groups and rural communities, this gave *them* regulatory uncertainty. It was unclear not only for communities, but also for state and federal regulators what agricultural stormwater actually was in practice. I said It was unclear where the field ended and when the “point source” began. It was confusing which runoff was legal and which was not. When I brought up to one regulator in Wisconsin that I was having difficulty differentiating between the two, they laughed and replied, “Yeah you and everyone else,” (Regulator 4 2022). Indeed, the agricultural industry was perfectly content creating uncertainty for everyone but themselves. Each time industry came up against regulations they did not approve of, they found a way to eliminate them within 1-2 years. For example, duty to apply was struck down within a year of the establishment of the CAFO rule in 2003 and again in 2008. This also eliminated the penalties related to failing to apply for a permit, thus the only changes the agricultural industry had to make after the 2008 CAFO rule was to create NMPs.

Nutrient management plans are technical plans created for farmers to manage the manure on their farms. The literature within soil science, agricultural economics, and guidelines prepared by state regulatory agencies frames NMPs as legitimate and scientifically established tools that enables farmers to avoid creating agricultural runoff (Janni and Cortus 2019; Spellman and Whiting 2007; Havlin 2020). NMPs are technical documents and require the use of high-skill services such as soil testing, nitrate-nitrogen testing, and manure analysis (Wolf 1998; Beegle et al. 2000). When it comes to preparing these plans, these are services that the farmer may not

know how to fulfill, or have time to do so. One regulator from Wisconsin, for example, noted that farmers have enough work on their hands. As a result:

...the vast majority of the time, the farm just hires a crop consultant and they develop the plan and submit it and work with DNR throughout the whole review process. You know most of the time in my experience, the developing of nutrient management plans is a pretty technical and complex process and usually a farm operator has so much on their plate already. They can't wear the agronomist hat as well for their farm. So it makes sense to divide that labor up at the farm level depending on how big they are. But I'd say that, you know, at least ninety percent if not more of our farms hire crop consultants to do that whole process for them.

Historically, NMPs were prepared by Extension agents and other experts within the land-grant university system (Lawley, Lichtenberg, and Parker 2009). Since the 1990s, however, crop consultation services for NMPs have shifted from the public sector to private sector consultants as states aimed to pass costs over to the private sector as a function of neoliberalization (Wolf 1998). The information provided by these consultants often has a direct impact on how farmers operate on the micro-scale. Thus, a focus on the privatization of crop information is useful for understanding issues of rural environmental inequality because, “information markets at the community, farm, and field-scales are particularly important since this is where the environmental interface is most direct (i.e. soil, water, air, wild-life, humans),” (Wolf 1998:154).

According to Wolf (1996; 1998), the privatization of crop consulting services is part of larger trends reflective of the neoliberalization of agriculture. One clear dimension of neoliberalism in this case is the privatization of information services that used to be primarily offered by public institutions. Although Wolf (1998) did not explicitly frame these changes in terms of neoliberalism at the time, he did discuss these practices as, “Market-based strategies that are consistent with a shift in patterns of government intervention and are closely related to deregulation and privatization trends,” (155-156). From the 1990s onward, the public sector still

exerted some influence over agricultural production on the farm-level, but influence over field-level production was dramatically reduced.

Wolf's field research took place in the early 1990s. At that time, the Corn Belt, where Wisconsin is located, was already leading the way in terms of privatization of crop information services. Compared to the Mississippi Delta and the Mid-Atlantic, "In terms of the role of locally-based Extension agents, privatization is largely complete in the Corn Belt state[s] (no county agricultural Extension agents and limited regional programming)," (167). This was confirmed by my interviews with regulators at the WDNR. Wisconsin is 1 of the 8 states that have their own specific requirements to write NMPs. Farmers are not permitted to design their own NMPs unless they take several courses and pass an exam (Wisconsin Administrative Code ATCP 50.48 n.d.). Although this does happen, NMP regulators at the WDNR indicated that this is rare. The courses are time consuming and the exam has a failure rate over 80%. Most CAFO owners in Wisconsin, one regulator suggested around 90 percent of these farmers, typically hire a private crop consultant (Havlin 2020).

Private crop consultants tend to either be employed by the fertilizer and pesticide industry (in which case they are called "dealers") or act as independent crop consultants (Wolf 1996). The rise of agricultural consulting markets emerged as a targeted strategy by large agribusinesses within the fertilizer and pesticide industry as a new way to increase profitability during a period of immense concentration within the agrochemical industry (Wolf 1998). Agrochemical businesses saw crop information services as their next big source of revenue in the face of declining profits. Indeed, for Wolf (1998: 157), privatization of agricultural information was not only a feature of neoliberalization of the state, but also, "*consistent with a long run pattern of*

‘appropriation and substitution’ (Goodman et al. 1987) that underlies the industrialization of agriculture and concentration of political and economic power,” (emphasis added).

However, over time, crop consultants from the agrochemical industry increasingly came under scrutiny from regulators and academics. The most obvious issue with these crop consultants was the direct conflict of interest between the “dealer,” who worked for an agrochemical company, and farmers who were paying them for advice regarding how much of their employer’s product to put on their fields. Indeed, there are many studies that have shown crop consultants from the agrochemical industry are much more likely to suggest the application of higher rates of fertilizer and pesticides than independent crop consultants or agents from Extension services (Wolf 1996; Lawley, Lichtenberg, and Parker 2009; 2012; Beegle, Carton, and Bailey 2000).

For the agrochemical industry, seeking the assistance of technical experts in the first place, “[had] as much to do with agribusiness’ need to reinforce the legitimacy of high-input agriculture as it does with farmers’ demand for additional support,” (Wolf 1998: 157). Birch and Siemiatycki’s (2016) definition of marketization involves, “the introduction of markets and market forces into the state, primarily into its functioning, authority and legitimation,” (179). In response to the legitimacy crisis dealers were facing, the state enabled dealers to “borrow” some legitimacy from the state through the creation of a crop consultant certification program. Certification programs are another form of marketization in that they use the legitimacy of the state to enable practices that result in more state functions being handed over to the private sector. In 1991, the EPA, USDA, and the American Society of Agronomy, one of the largest academic organizations for crop experts in the US, initiated another PPP by creating the Certified Crop Advisor (CCA) program. This program was a direct result of the USDA’s recent decision

to monitor certain crop advisors who were accused of pro-agrochemical bias while at the same time granting autonomy to independent crop consultants. The National Alliance of Independent Crop Consultants followed suit that same year and established their own certification- the Certified Professional Crop Consultant program (CPCC). Overall, these certifications seem to have helped the agrochemical industry's cause. Recent studies of sources of information used by farmers in nutrient management decisions suggest that the most common source of information for farmers when it comes to nutrient management is fertilizer dealers, particularly in corn farming and in the Midwest (McBride 1998; Stewart et al. 2012; Arbuckle and Rosman 2014; Houser et al. 2019).

In contrast to dealers, independent crop consultants were highly respected by farmers because of their experience, attention to detail, and expertise of scientific knowledge related to agriculture (Wolf 1996). However, because dealers work with large companies and can take advantage of economies of scale, the services for independent crop consultants are typically more expensive. Due to high competition between independent crop consultants and dealers as providers of these advising services, over time the distinction between the two has become increasingly blurred as they have begun to collude. Specifically, the formation of "alliances" between dealers and independent crop consultants in the form of guaranteed referrals, sub-contracts, and exclusive service contracts make it more difficult for farmers and regulators to know which consultants are truly "independent."

On this subject, I received a response from a NMP coordinator at the WDNR who revealed confusions and tensions between NMP planners and regulators (personal communication 2022). While working through the literature within agricultural science and agricultural management to understand the basic workings of nutrient management planning, I

realized that there seemed to be no real distinction between planning application of chemical fertilizers and manure:

D’Onofrio: Could I interrupt for a sec? I’ve been having some kind of trouble because the literature often talks about manure and chemical fertilizers the same and like I know that’s not the case for nutrient management planners, they don’t think of it that way. Correct?

Regulator 5: Right. I mean there’s different nutrient contents. There’s different, especially for CAFOs, there’s different rules for land applying that.

When I brought up confusions about nutrient plans with the NMP coordinator, they connected it to crop consultants. Here, the regulator revealed that a tension exists between the people who plan NMPs and the regulators themselves:

Regulator 5: Yeah. And, and probably the reason that you’re running into that is because when you look up like what nutrient management is as a whole, it’s about managing the nutrients on the fields. When you talk to somebody who’s like, professional nutrient management planner, their number one concern mostly, and I shouldn’t say this for everybody, but mostly, if that’s your profession, your number one concern is how to manage the nutrients for crop production.

D’Onofrio: Yeah. Yeah.

Regulator 5: Ya know what I mean? And so that involves manure applications, fertilizer applications, different things, you know, nitrogen inhibitors and thaw and things like that. Whereas our standard and especially NR 243 and CAFOs is what we’re focused on mostly is Environmental Protection, so protecting the surface and groundwater. We’re not as concerned about, ‘do they have enough fertilizer or nutrients on the field to grow their crops?’

D’Onofrio: Yeah. Okay.

Regulator 5: I mean, so that’s kind of a balance and so that’s probably why it’s hard to find stuff specific about manure, especially for our rules, because our rules are focused on protection of groundwater, not nutrients for growing crops.

Throughout the interview, there was no distinction between dealers or independent crop consultants and the regulator who “reviews most of the NMPs” for CAFOs in the state of Wisconsin despite the fact that I was explicitly asking to understand it. This suggests that the findings from Wolf (1996) almost three decades ago remain relevant today.

This lack of distinction is concerning considering that a recent report from the Environmental Working Group (EWG) and Midwest Environmental Advocates (MEA)(2022) found that by combining chemical fertilizer and manure, farmers are dramatically exceeding the nutrient capacities of their fields despite regulators' insistence that these issues should all be addressed by tools such as SnapPlus. In reality, farmers in Wisconsin have increased their purchases of chemical fertilizers over the past 20 years at the same time CAFO waste increased. Between 2004-2018, the amount of nitrogen fertilizer purchased in the state doubled (EWG and MEA 2022). Their analysis of nine CAFO-heavy counties, including Kewaunee County, found that when both chemical fertilizer and manure were taken into account, eight out of nine counties spread more nutrients than the fields could hold. In four of the counties, nutrients were applied at over 50 percent of the rate recommended by the University of Wisconsin. Kewaunee County, which has the highest concentration of CAFOs in the state, had the highest rate of overapplication, with 196 percent of the nitrogen recommendation being met by these practices. According to their analysis, EWG and MEA (2022) calculated that across the nine counties, farmers would need to access 64 percent more acres of land than they currently do. These findings suggest that either farmers are not following these plans or they are not enough in the first place to regulate agricultural runoff.

Given current regulations farmers must apply the NMP to their fields and use the available tools they have at their disposal to handle CAFO pollution. Qualitative research with farmers provides us with more insight as to whether and how these plans are actually implemented, in practice (Osmund et al. 2015; Perez 2015; Tao et al. 2013; O'Connell and Osmund 2022). Perez (2015), for example, interviewed 60 farmers around the Delmarva Peninsula on the east coast. In 1997, after a highly publicized fish-kill event in the Chesapeake

Bay, Delaware, Maryland, and Virginia began to require NMPs for farmers, especially poultry CAFO operators. Their findings highlight several key themes that are also touched on throughout the literature on farmer behaviors and nutrient management in practice.

A troubling theme in this literature is the disconnect between farmers themselves and the environment. For decades, agricultural scientists pushed for mandatory soil sampling with the assumption being that farmers would use this knowledge to more precisely manage fertilizer and manure (King 1999). While 98 percent of farmers used techniques such as soil testing, these were not the only tools farmers used to make decisions on their day to day field operations. According to their interviews, “...many admitted they could not read their results when they received them or made rate decisions before the results came from the lab due to timing issues and delays on the part of the farmer and the labs,” (O’Connell and Osmond 2022:4). A majority of the farmers interviewed by Perez (2015) believed that the farmers themselves were the most knowledgeable about their fields, and therefore, did not need expert assistance. Farmers often substituted their own knowledge or “gut feelings” about nutrient application based on their experience as farmers. As one farmer in Southern Maryland told Maloney and Paolisso (2006), “I still believe agriculture to be a little more art than it is science,” (80).

However, in practice, studies measuring their “gut feelings” found that this often leads to overapplication (Osmund et al. 2015). This disconnect that farmers had between their perceptions of the impact of their actions had on the environment and the actual impact they had on the environment reflects the uncertainty, but also the hubris that comes with agriculture in practice, even by seasoned farmers. This is because, just like crop consultants, farmers are mostly concerned with yields, not environmental compliance. It makes sense, then, that farmers in Perez’s (2015) study did not believe that agriculture was the largest source of pollutants in the

Chesapeake Bay nor did they believe that phosphorus causes environmental problems since they understood their own farming practices to be environmentally sound. In almost all of the interviews, farmers opposed NMPs because their goal is to maximize yields, and they believe that more fertilizer will achieve that goal.

In a more recent study using interviews of 104 farmers across the country about their nutrient management practices, O'Connell and Osmond (2022) found that farmers only partially use nutrient management plans. In almost all of the interviews, farmers opposed NMPs because their goal is to maximize yields, and they believe that more fertilizer will achieve that goal. Specifically, the farmers in this study framed the use of fertilizers as a way to increase (or at least, feel like they are increasing) the likelihood that their crop will flourish given all of the other uncertainties, such as agricultural markets, weather, and pests, that farmers work with on a regular basis. Despite the fact that farming is ultimately an activity that requires direct involvement with the environmental conditions of production and the rationale that farmers offer for their over-application of fertilizers, another key driver of overfertilization is economic. As noted by Perez (2015), in almost all cases, farmers opposed nutrient management plans because their goal was to maximize yields.

Several farmers described the act of overfertilizing as almost a form of insurance (Houser 2022). According to one farmer, "Well, if we would split shot the nitrogen, I think we could cut back some on the nitrogen. But in past years, we've got, like I said before, caught in the rain and didn't get on what we thought we needed. So, kind of an insurance blanket, I just put her [nitrogen] on," (O'Connell and Osmond 2022: 4). To put it another way, as explained by Sheriff (2005), there are many ways that farmers use fertilizer and manure that are not efficient from the environmental perspective, but are in terms of economics. This includes the overapplication

scenario described above, but it also explains why farmers over-apply manure on fields as a form of cheap waste disposal to avoid paying for manure hauling costs.

Section 3.4: The Importance of State Variation in CAFO Regulation: CAFOs in Wisconsin

As I noted at the beginning of this chapter, from the birth of the CWA, the EPA gave states the power to create and regulate their own NPDES permits. Wisconsin, the central site of this dissertation, has their own permit called the *Wisconsin Pollution Discharge Elimination System* (WPDES) permit which is regulated by the WDNR. For CAFOs whose number of animal units falls below 1000, permits are purely voluntary unless the state requirements are higher than the federal permit, which is the case in Wisconsin. In interviews with regulators at the WDNR, I learned that a big difference between the baseline NPDES and the WPDES permit is that Wisconsin has a “duty to apply” for a permit once they reach a certain threshold regardless of whether they have “potential to discharge” pollutants. According to one of the permit coordinators at the WDNR, duty to apply means that:

...before you exceed that 1,000 animal unit threshold, you're required legally to submit a permit application to us. The way the federal program does it only requires farms that have an actual discharge that are over 1,000 units to obtain permit coverage. So most states follow that framework. So it will have some farms that have, you know, thousands of animal units, but since there's no potential to discharge, they're not required to get permit coverage. Whereas in Wisconsin, we oversee all of those farms. (Regulator 5, Personal Communication 2022)

However, the way that this was described by the regulator obscured the big picture of CAFO permitting in Wisconsin. Because of this high threshold, a very small percentage of CAFOs in Wisconsin actually reach the size where they would need a permit. For example, the state of Wisconsin has the highest number of dairy farms in the US (about 6500 farms), but every year that number has been shrinking as farms get larger (Kirwan 2022). Today, the average Wisconsin

dairy farm has 217 cows (Wisconsin Agriculturalist 2023). The average number here would fit into the designation of a medium CAFO. However, since the WDNR only monitors large CAFOs, this means that most of the dairy CAFOs in the state are not being monitored by the WDNR. Indeed, in their analysis of only 9 counties in Wisconsin, the Environmental Working Group and Midwest Environmental Advocates (2022), using map software and site visits found over 1000 farms in those counties but only 3 percent were permitted by the WDNR.

In my interviews, I asked each of 5 regulators the basics of permitting, compliance, and enforcement of CAFOs in Wisconsin. In terms of the back and forth between the regulators and the farms to establish these permits, Regulator 1 (Personal Communication 2022) described their job like this:

I would review permit application materials, consult with the technical review experts. There's like, we have an engineer, look at one of their things. After those consultations, I as the regional specialist draft the permit, the public notice the permit, run any kind of hearing or public input process. Have all the conversations as I'm the first point of contact with the farm and all their Consultants. [Then] Come out with the final permit. Probably do all the outreach about, 'Hey, this is what your permit to that farm.' And then on the same person that did the pre permitting inspection on the farm- boots on the ground- and I'd be the same person to do that first, like, mid-year inspection assessing compliance with the permit. Plus I'm the same person that's checking boxes for receiving any necessary reports. So you've got like one point of contact or like one project manager for anything associated with that farm.

Those farms are also required to have an NMP. A NMP reviewer for the WDNR described the process of planning for the NMP this way (Regulator 5 2022):

...there's another standard that's called the NRCS 590 standard and that's a standard that's created by NRCS, which is a federal entity. And then Wisconsin adapts their version of that code. And that's kind of the overlying code that all farms in Wisconsin have to follow if they have a nutrient management plan or required to have a nutrient management plan. So then CAFOs are required to meet the 590 standard but then also meet the additional requirements that are laid out in 243, the additional nutrient management requirements. So what they- it's starting to be long-winded- but what they have to do as part of this permit is that they have to submit us a plan that shows at least five years that they can comply with all the thresholds that they have enough land to

apply all their manure. And then what part of my job is, along with some other people in the DNR, is to review those plans and make sure that they meet all those requirements. And then we make a determination that yes, this farm has enough land to apply all the manure and process wastewater that they're going to produce. And then we send it an approval letter and that nutrient management plan becomes part of their permit.

They are also required to consult with the engineering staff at the WDNR to ensure that their manure storage spaces, such as manure lagoons, are in compliance and free of leaks (personal communication 2022). Not only does Wisconsin have their own standards, but they have their own site specific technological tools they have developed for nutrient management in conjunction with the University of Wisconsin called “SnapPlus.” This technology³ enables farmers to find out if they are handling manure responsibly, in real time under real weather conditions.

Several times throughout this chapter, I have mentioned that environmental regulation in Wisconsin is weak. It is hard to get a sense of how weak it is until their enforcement process is taken into consideration. In the state of Wisconsin, the DNR does not have the authority to give citations to entities that are violating environmental law:

...we don't have citation authority in our program. So, like citation. It wouldn't be applicable here. Anyways, never mind, that not... if we have a written letter, like a notice of violation or notice a non-compliance to a farm, legally we are *alleging* non-compliance with a Permit condition. It's not- It's like getting a speeding ticket. You could take that speeding ticket to court and contest it. Most of the time people don't because they'd rather just pay a hundred bucks or whatever. But that's what our enforcement actions are like. You are not guilty the day you get the ticket, you're guilty of the day your court date comes up. Same process (Regulator 1 2022).

The process for resolving noncompliance is highly informal and non-adversarial:

³ In many ways, this is a great example of precision agriculture, which emerged at precisely the same time as the privatization of NMPs in the US.

What we're going to try and do is resolve the alleged non-compliance at the lowest level of enforcement necessary to do that efficiently and completely and whatever. So it's very common for us to say, 'Hey, you know, you have this, you have this event happen. You need to make changes, to make sure that kind of stuff doesn't happen again.' Farm says, 'Yeah, I agree. I'll do this to make sure that doesn't happen.' We'll say 'Great' and they do the thing, we verify the thing was done and we close the enforcement action. So it never got essentially to the day like the day in court where it becomes an actual violation (Regulator 1 2022).

Here, it is important to understand that in many ways regulators only have a limited amount of power because their job is to uphold regulations as they currently exist and the regulations themselves limit the power of the agency. In Wisconsin, environmental regulators are required to follow what is called "stepped enforcement." This describes, "a series of incremental actions designed to resolve violations at the lowest level appropriate for the circumstances and to judiciously use agency resources to achieve compliance," (WDNR Bureau of Law Enforcement 2013: 2). Even in cases where the CAFO is a chronic polluter, regulators have to use this process to resolve any "alleged" noncompliance that they or a neighbor of a CAFO discover or is revealed in self-reported data.

But how does it make sense for a regulatory agency, whose entire purpose is to uphold and enforce certain laws, to be banned from enforcing the law? When I asked regulators, Regulator 3 (2022) directed me to statute 283 in Wisconsin State Law, but they had no idea when the policy was enacted. Statute 283 includes the regulations for pollution discharge elimination (Wisconsin State Legislature 2023). The bottom of the first section includes a note indicating when major changes to this regulation took place, in 1973 around the passage of the CWA and 1995. In 1995, substantial changes were made to this regulation which crippled the WDNR's ability to enforce pollution standards on their own without approval from the Department of

Justice. These changes are not isolated, but were in fact a part of the process of neoliberalization of Wisconsin.

Starting in 1995, the state of Wisconsin began aggressively dismantling the programs, policies, and political institutions that supported the creation and enforcement of environmental policy (D'Onofrio 2022). This process began after the re-election of Conservative Governor Tommy Thompson and the election of a Republican majority in the state legislature for the first time since the late 1960s. Some of the most drastic cuts directly influenced the structure of Wisconsin's environmental regulators: the WDNR and the Office of the Public Intervenor (OPI)⁴. First came the roll-back, which was originally framed as a boring state budget reorganization, which deliberately targeted the sources of funding that kept these agencies afloat. The proposed budget called for severe cuts to the WDNR, including the elimination of over 400 staff members (Sinykin 2004). Simultaneously, the OPI, the watchdog that was supposed to keep the WDNR in check, was eliminated by cuts to the Attorney General's office. Then, new regulations were put in place to limit the power of the state and encourage expansion of the private sector. After 1995, Wisconsin was put on a path where neoliberal logic was made increasingly achievable since there was no longer an adversarial force strong enough to resist it. 1995 was not the beginning of intensification of agriculture in Wisconsin, but was a key tipping point as state level policies began to mirror neoliberal policies on the national level.

⁴ The OPI was a regulatory body unique to Wisconsin that was established in 1968 as the outcome of a compromise between populist social movements and industry groups (Huffman 2000). The responsibilities of the OPI were to advocate, inform, litigate, and enforce environmental policy. During the period the OPI was active, Wisconsin paved the way for environmental policy in the United States (Sinykin 2004).

Section 3.5: Conclusion

Over 50 years after the passage of the CWA, it continues to be unclear for the regulation of CAFOs. The EPA has shown no desire to clarify it as evidenced by the fact that they left environmental groups in the wind for over 5 years without a response. To be sure, the lack of decisive action from the EPA may reflect the political impasse in Washington, as well as the loss of key personnel during the Trump Administration, but the effect continues to be that of a weakened and anemic regulatory agency. In lieu of effective regulation, NMPs remain the go-to tool for state regulatory and knowledge producing institutions for managing runoff from farms. Yet NMPs have serious limitations. Since the 1990s, NMP planning has become heavily privatized by the fertilizer industry despite their direct conflict of interest. There are also issues with how the farmers themselves apply or do not apply these plans in practice. But the regulations themselves are not the only issue here. The reason why NMPs are self-regulated and privatized is because the state, on both the federal and state levels, have embraced neoliberal forms of (self-) regulation. Neoliberal regulation prioritizes the deregulation, privatization, and marketization of the state. Since the 1980s, federal and state regulatory agencies for the environment have been gutted by deregulation as I showed in the case of the EPA and the WDNR. They have ironically been further crippled during a period of re-regulation that prioritizes the growth of the private sector over protection of the environment.

While this chapter has focused on water regulations and their neoliberal governance in Wisconsin resulting in environmental injustice in rural, predominantly white regions, in the next chapter, I bring California back into the picture by discussing their programs that are driving current patterns of digester development on dairy CAFOs in Wisconsin. In order to cash in on these marketized programs, a CAFO has to demonstrate to the California Air Resources Board

(ARB) that they are following *all* local, state, and federal regulations— including water regulations. But as I have discussed throughout this chapter, the existing regulations at the local, state, and national level for CAFOs do not protect water sources from their pollution. Due to the weakness of environmental regulations around CAFOs and the unwillingness of the state to monitor agricultural runoff, the choice of CARB to allow credits from these specific facilities remains at best, oblivious and at worst, corrupt.

The point of this dissertation is not to critique ARB alone but the practice of “public private partnerships” in environmental regulation which have become the norm over the past three decades across all scales of regulation in the US. Indeed, California’s climate mitigation programs are primary examples of the neoliberalization of environmental regulation since they built up markets that commodify pollution and further privatize and marketize state functions.

Chapter 4: The Evolution of Capitalist Agriculture within the State/Science/Industry Nexus

The Marxist theory of the capitalist mode of production does not merely consist in reducing development to the formula 'elimination of the small establishment by the large'... Rather, it has to consider all the changes through which agriculture has passed over the course of the capitalist mode of production: *whether, and how, capital is seizing hold of agriculture, revolutionising it, making old forms of production and property untenable and creating the necessity for new ones.*

The Agrarian Question (Kautsky 1899: 12)

Section 4.1: Introducing the Agricultural State/Science/Industry Nexus

In the political economy of agriculture, it is by no means a theoretical breakthrough to highlight the deep connection between state institutions that regulate agriculture and the agricultural industry. According to McMichael (2005; 2009), the current era can be characterized as a “corporate food regime” as food production continues to follow patterns of neoliberal globalization which disproportionately benefit large agribusinesses at the expense of peasants farmers across the world-system. Indeed, in the context of biofuels (also called agrifuels), McMichael (2009) explicitly frames the modern agrifood system as a “state/corporate nexus.” However, since the central question in this dissertation is specifically focused on the development of a certain agricultural technology (such as manure digesters on CAFOs) and why it was chosen as the key “solution” to GHG mitigation on CAFOs, it is useful here to add another dimension: science and technology.

In this chapter, I use comparative historical analysis to connect the story of manure digesters to the history of the capitalist development of an “industrial” agriculture which favored the use of specific technologies over time. Despite the prevailing logic that the private sector is the source of “innovation,” not the state, in the realm of agriculture, many advanced technologies that used by the private sector today were either funded by the state or were developed within

state funded universities (Slaughter and Rhodes 2004; Heisey et al. 2006). The coalition that emerged from this co-evolution I refer to as the state/science/industry nexus. The state/science/industry nexus of US agriculture describes the historical and contemporary interconnectedness of state knowledge producing institutions in the agricultural sciences and the private industries which have sought to use this knowledge to create, promote, and normalize technologies needed to surmount nature/labor barriers to capital accumulation within agriculture. Indeed, my goal here is also to highlight that long before neoliberalism emerged in the 1970s, there were already networks of actors within agricultural knowledge production whose goals gave a distinctive advantage to the largest and wealthiest agricultural producers. For example, throughout the entire chapter, I refer to the American Farm Bureau Federation (AFBF) as a key example of one of the organizations in the private sector that has benefitted the most from this nexus considering the AFBF originated within Extension services at LGUs where they remain immensely influential today.

The agricultural industry not only relies on the state for their knowledge producing capabilities, but also because the state is able to implement policies favorable to the development of entire markets where they were not able to exist before due to capital constraints. This partially helps explain why certain “solutions” are promoted to reduce GHG emissions on farms: some have markets and some do not. Where they do not, the neoliberal state needs to assist in forming them. As I discuss in the example of biofuels, the ethanol industry was on the verge of death many times before it was brought back to life by government funding and favorable policy concessions (Crooks and Dunn 2006). The development of agrifuel infrastructure in the US was not necessarily a project of “greening fuel,” but rather a coordinated effort on the part of the agricultural industry to simultaneously address declining profitability of corn in food products

and a sharp rise in input costs for farmers by shifting many of these costs onto the state (Baines 2015). The rise of anaerobic digestion on dairy CAFOs did not magically appear out of the blue but was, in fact, built upon existing infrastructure, technology, and policy related to agrifuels, specifically corn-based ethanol. Here, we can see the importance of the “stickiness” of history, particularly in the case of agrifuels.

Section 4.2: Tracing the Development of the Agricultural State/Science/Industry Nexus

In the context of the agricultural state/science/industry nexus, it is important to note that “science” within agriculture is very unique because it comes with its own set of knowledge producing institutions: LGUs (LGUs) and Cooperative Extension services designed to actively produce and share agricultural knowledge with farmers themselves. The fact that these institutions, many of which are the oldest educational institutions in the US, were created and designed to foster the creation of an agricultural industry makes these spaces important for my analysis of the evolution of agricultural research and development (R&D) over time.

Within the policy debates around the establishment of agricultural research institutions, the class interests, according to Busch (1982), are quite clear throughout what he identified as three key periods in the history of agricultural research and development. The first period, the 1860s-1880s, was characterized by policy debates around the Morrill and Hatch Acts which created the system of agricultural research institutions that exists today. The Morrill Act not only established the USDA, but it also created the land-grant university system which is central to agricultural research and development as it exists today. Utilizing recently dispossessed Indigenous lands, the Morrill Act redistributed these lands to states with each state gaining 30,000 acres per representative in Congress (Busch and Lacy 1983). States would use funds

generated from the sale of these lands to set up what would eventually be called LGUs. If some states did not have access to land for LGUs in their state, land was provided to them from somewhere else. For example, when there was not enough land surrounding Cornell University in New York, the university was granted access to strips of land in Northwestern Wisconsin (Vogeler 1981). A town with the same name exists there to this day.

By the 1870s, elites and politicians began to push for the establishment of agricultural experiment stations, which are research centers for agricultural production connected to LGUs, for three key reasons (Busch 1982). The first reason for this shift was due to a rising tide of discontent in rural areas across the US. Between 1863-1869, the US encouraged the rapid expansion of railroads with the goal of creating a transcontinental railroad. These railroads spurred development in rural areas and drove up the costs of living (Busch 1982). By the 1880s, rural unrest began to emerge as mortgage rates increased and, “As a result, [rural communities] began to advocate radical changes in the distribution of wealth and power in American society,” (Busch 1982: 389). In other words, one of the central reasons for the shift to elite support of experiment stations was because they believed that these institutions would quell the rising tide of populist social movements. The movements in rural spaces were actively challenging elite positions in society.

Not only was there discontent among rural populations during this period, but there was also concern about urban uprisings caused by high food prices. Between 1830-1930, the percentage of the US population living in urban areas rose from 10 percent to 60 percent (Boustan, Bunten, and Hearey 2013). Indeed, this was a time of massive social change for both rural and urban spaces as they experienced an immense influx of people, not just from rural spaces within the US, but globally as millions of immigrants began moving into urban spaces

(Hirota 2018). The goal for urban elites was to increase food production and keep the cost of food low, thus undermining worker demands for wage increases (Busch 1982). Lastly, elites pushed for the establishment of experiment stations as a way to avoid taking on the costs of research and pass them onto the state. This is exactly what Moore (2018) was describing in his discussion of accumulation by appropriation.

The establishment of LGUs was initially challenged by members of urban elite educational institutions such as Harvard, Yale, and Princeton (Vogeler 1981; Busch and Lacy 1983). Part of the reason for this contestation was because the Morrill Act fundamentally reshaped how universities operated, not only in the realm of agriculture, but university research in general. In fact, the Morrill Act ignited intense debate within academic institutions because LGUs placed a special emphasis on *the development of applied research* instead of teaching alone, which was the norm for universities at this time (Vogeler 1981; Busch and Lacy 1983). During this period, as noted by the Regent of Illinois Industrial University in 1869 (Busch and Lacy 1983: 9):

Looking at the crude and disjointed facts which agricultural writers give us, we come to the conclusion that we have no science of agriculture. Botany is a science- chemistry is a science- but agriculture is not a science in any sense It is simply a mass of empiricism.

Indeed, it was not scientists, but politicians and wealthy farmers within agricultural colleges that sought to reshape how knowledge was created within academia. During this period, scientists of the day remained unaware of the emergent movement within agricultural colleges towards the “scientization” of agriculture based on von Liebig’s experiments in soil chemistry (Busch and Lacy 1983). This coalition of capitalists, politicians, and urban elites who supported the rationalization of agriculture saw the Morrill Act, and eventually the Hatch Act, as an opportunity to establish agricultural science as *a legitimate form of scientific research*. The

Hatch Act of 1887, for the first time, mandated that state funds and institutions should be used to develop a *permanent agricultural industry* (Vogeler 1981).

By 1900, agricultural science was established as a legitimate discipline within academia (Busch 1982). It was during this time that there began to be a growing movement among elites committed to a reorganization of rural life beyond agriculture. In the words of agricultural scientist Kenyon Butterfield of Massachusetts Agricultural College, “There must be a union of the country school teacher, of the agricultural college professor, of the rural pastor, of the country editor, with the farmers themselves for the production of an increased crop of new farmers,” (Busch and Lacy 1983: 19). The Smith-Lever Act established Cooperative Extension services, also referred to as “Extension”, which took the knowledge produced within LGUs and experiment stations and shared it with local farmers, thus creating the “crop of new farmers” that was so desired by agrarian intellectuals (Busch and Lacy 1983; Gilbert 2015). The creation of extension programs also enabled those same scientists to focus more on their own research since extension services took over the role of dealing directly with farmers (Busch 1982).

The Smith-Lever Act also created “agents” on the state county level, referred to as “county agents,” who would act as the middleman between agricultural research centers and farmers themselves. However, issues quickly arose as it became increasingly unclear who these agents worked for (Busch 1982). The payment structure for agents in Smith-Lever Act was funded by the federal government, state and local governments, but also *private entities*, including an organization which eventually became the American Farm Bureau Federation (AFBF). Today the AFBF is an insurance company and one of, if not the most, powerful nongovernmental lobbying organization for industrial agriculture in the United States. According to McConnell (1953: 48):

One of the best-documented facts about the Farm Bureau Movement is that it was a direct outgrowth of the County Agent System. All the instructions to agents from their department were based upon the assumption that the first part of the agent's work would consist in organizing Farm Bureaus.

In many ways, the payment structure of these county agents strengthened the legitimacy of the AFBF as an organization since agents' salaries were *paid by bureau membership dues* (Campbell 1962).

By 1920, the Association of Agricultural Colleges and Experiment Stations, which initially supported the terms of the Smith-Lever Act, had become concerned about the amount of political influence held by the AFBF, particularly after they were able to organize a national federation. Indeed, the Association grew increasingly uncomfortable with the political nature of what was supposed to be an educational organization. When Congress investigated the ties between the AFBF and extension programs, they ultimately determined that the American Farm Bureau Federation was illegally acting as, "both a lobby and a quasi-governmental organization," (Busch 1982: 379). Congress responded to these findings by negotiating and reaching an agreement between the AFBF and extension agents which defined the roles of extension agents. After 1921, the official role of extension agents was to educate. Promotion of specific organizations was, at least according to the law, explicitly banned within the extension service. In practice, however, the AFBF continued to exercise substantial influence over extension agents which proved immensely consequential for the organization of the USDA in years to come.

By the early 1930s, the AFBF had experienced several immense political failures and was in the midst of a legitimacy crisis. In response, they sought to form a coalition with two other

dominant farmers organizations, the National Farmers Union⁵ (also called the Farmers Union) and the National Grange (McCune 1956). Despite the fact that members of the National Grange were hardly involved and members of the Farmers Union were actively excluded from this “coalition” after 1934, the AFBF began to aggressively push the idea that they represented the “voice of agriculture,” which remains their slogan to this day (McConnell 1953; Farm Bureau 2022). Indeed, despite the claim that the Farm Bureau was the voice of all farmers, it was clear by their intense hostility to any organization or policy that challenged the dominance of capitalist agriculture, particularly during the New Deal era, that the AFBF had no desire to appeal to populist farmers.

The New Deal foundationally reshaped how the state operated and agriculture was by no means exempt from these immense changes. In Jess Gilbert’s meticulously researched book *Planning Democracy* (2015), Gilbert traced the creation and implementation of what he called the *Intended New Deal*: “...America’s first nationwide public policy initiative in democratic planning,” (242). Here, I will focus on another central institution within US agriculture which, in many ways, brings the nexus together: the *US Department of Agriculture*. After WWI and the Great Depression, there was an explicit effort on the part of the New Deal USDA to create and implement a comprehensive system of land-use planning that connected farmers in the (often disconnected) countryside to state agencies and knowledge producing institutions and then directly to Washington. This task was carried out by a group that Gilbert (2015) referred to as the “agrarian intellectuals.” Included in this cohort was Henry Wallace (secretary of agriculture from

⁵ The Farmers Union and the AFBF ultimately represented very different interests. The Farmers Union consisted of a large number of low income farmers who often challenged the policy choices of the AFBF which typically favored large-scale capitalist agriculture over small family farms. Up until the 1930s, the leadership of the Farmers Union still included farmers from the “old populist tradition” who were often framed as aggressive, militant, and radical (McConnell 1953).

1933-1940), M. L. Wilson (undersecretary of agriculture and director of federal Extension), Howard R. Tolley (chief of the Bureau of Agricultural Economics), Carl C. Taylor (a well known rural sociologist), Lewis C. Gray (land planner and agricultural historian), and Bushrod Allin (agricultural economist and top planning official).

According to Gilbert (2015), the agrarian New Deal's goals were twofold. The first key goal was to actively increase the participation of farmers (whether all of those farms were actually included is discussed below) within New Deal programs. Specifically, the agrarian New Deal, "...sought to democratize the government functions of administration, education, research, planning, and policy making," (242). Between the 1860s and the 1930s, LGUs and extension services had become established as knowledge producing institutions, but that knowledge was not being used democratically, at least from the perspective of the agrarian intellectuals. In other words, the "average farmer", which at the time included tenant farmers and sharecroppers, was still excluded from reaping the benefits of education or funding from programs that were offered by the state. This exclusion was particularly normalized among white landless farmers and minority farmers. Indeed, by the early 1930s, the US was in the midst of a poverty crisis among farmers with half of all farmers lacking steady access to land (Gilbert 2015). A report from the USDA in 1937 revealed that between 1880 and 1935, the number of tenant farmers as a percentage of all farmers rose from 25 percent to 42 percent.

The first program within the agrarian New Deal, Agricultural Adjustment Act (AAA) of 1933, was passed as emergency legislation in response to historically low crop prices and increasing rates of starvation among farmers. The AAA created a program to pay farmers to plant on fewer acres of land with the goal of driving down supply and providing farmers income as a means to increase consumption. Although the AAA was "successful" in that it provided

payments to over 5 million farmers within two years, it was clear that the architects of the AAA, the agrarian intellectuals, did not fully understand the inequalities that were embedded within American agriculture at the time. Specifically, they did not understand that the way the AAA was designed only benefitted landowners. According to Gilbert (2015: 85 emphasis added):

Most of its framers, including Wallace, Wilson, Tolley, and Black, assumed in 1933 that propertied farmers should be helped first in the economic crisis. Indeed, this is what *farmer* meant to them, the neighbors they grew up with in the rural Midwest. The agrarian intellectuals sometimes spoke of a unitary farming class and may have fooled themselves into thinking that most American farmers were more or less similar, sociologically speaking. But they really represented midwestern family farmers, acting as organic intellectuals of that specific class. In forming and implementing the early AAA, *they were not thinking of southern landlords or California capitalist farmers, much less of sharecroppers or farmworkers*. In the early New Deal, the subordinate classes were virtually invisible to the agrarian intellectuals.

As Gisolfi (2017) mentioned in her analysis of the history of poultry production in Georgia, “Throughout the South, many, if not most landed farmers pocketed the [AAA] allotment money, sent tenants out to the fields to plow up a third of the crop, and then cast them off the land or hired them as day laborers,” (30). The agrarian intellectuals were not only wholly unprepared to deal with class inequalities in rural spaces, but racial inequalities as well. They were particularly unprepared to deal with the rampant racism against Black farmers and sharecroppers which quickly became a part of the program in practice as White landowners increasingly occupied key positions within local AAA boards.

The second goal of the program was to further integrate the new “activist” USDA with their conservative counterparts at LGUs and extension programs. The idea was that by creating a complex network that integrated the USDA and land-grant institutions with grass-roots knowledge that came directly from farmers, the agrarian intellectuals could re-shape rural knowledge production, and ultimately rural society, without the charge of government overreach.

In the initial negotiations with various heads of LGUs on the implementation of central planning efforts, the USDA leadership decided to, whether as a sign of good faith or a partial truce, put the Extension service in charge of carrying out the various programs within the agrarian New Deal. Indeed, the “boots on the ground” in charge of implementing the USDA’s programs were typically Extension agents or appointed by agents. Over time, it became clearer that Extension was actively undermining the goals of central planning and favored a specific type of farming that primarily benefited white, land-owning farmers with large amounts of capital.

In 1937, the RA became the Farm Security Administration (FSA). One of the strategies used by the FSA to reduce poverty was to provide financial support for small scale family farmers. Although initially, the AFBF did not object to the creation of the FSA, between 1941-1946, the AFBF launched a coordinated attack on the FSA with the leadership arguing that any financial support for small family farmers should be cut off (McConnell 1953). According to the AFBF, these farmers were “inefficient” and should not be rewarded for failing to adopt more productive techniques and technologies. These tensions escalated further when the FSA decided to institute a minimum hourly wage for cotton pickers. In response to these changes, the Farm Bureau quickly allied themselves with cotton growers and commodity organizations to denounce the new minimum wage and strengthen their calls to eliminate the FSA. As noted by McConnell (1953: 125):

A case can be made that FSA programs constituted a real and present threat to established systems of large-scale farming. According to this, the key to the situation is in a cheap and docile labor supply... So far as the FSA sought to make the labor market efficient, it sabotaged the consistent efforts of corporation farmers to maintain an oversupply of labor.

Once again we see the emergence of class interests within the state/science/industry nexus. As soon as the opportunity presented itself, the Farm Bureau sought to align itself with groups that

represented the largest and wealthiest producers in agriculture at the time. However, the aims of the Farm Bureau were larger than the elimination of the FSA. Indeed, the elimination of the FSA was only a part of a larger plan to reshape and control the workings of the USDA. The ultimate goal of Farm Bureau was to shift the oversight of farm programs back into the spaces it could control: the Extension services within LGUs where the bureaus themselves were born (McConnell 1953).

By the mid-1940s, the AFBF had gotten what they wanted: the elimination of New Deal reforms that focused on poverty reduction and a sharp rise in membership while, at the same time retaining influence within the Extension services. Membership within populist farmer organizations such as the Farmers Union declined. It is important to highlight that timing also played a large role in the decline of the Farmers Union at the same time the AFBF was gaining members. Specifically, the Farm Bureau was able to gain legitimacy while simultaneously undermining the legitimacy of the Farmers Union by framing them as communists during the McCarthy era (Pratt 1996). This had a profound impact on the way farmers organized, thus the types of policy solutions that they sought. According to McConnell (1953), between the 1930s-1950s, farmers stopped organizing on the basis of class, in large part thanks to the work of the AFBF, and instead organized around price policies and advancing the production of specific commodities which McConnell (1953) referred to as “commodityism.” As agricultural production became more specialized in the mid-20th century, this only served to further divide farmers according to the specific type of commodity they produced.

From the late 1950s onward, any trace of the agrarian left had been pushed out of dominant farmer organizations and had relatively little power to influence national policies. As a result, policies that aimed to address rural social problems, including rural poverty, the decline of

the small farm, and environmental problems diminished over time (Vogeler 1981). By 1970, the AFBF had clearly won the battle amongst farmer organizations to become the most politically powerful (Hansen 1985). As I show in the following sections, moving forward, the AFBF did not change its preference for large-scale agriculture and continually lobbied for or passively accepted appropriationist/ substitutionalist agricultural technology that benefited the largest farms at the expense of the smallest which disputes their claim that they represent the “Unified Voice of Agriculture” (AFBF 2023). For the remainder of this chapter, I show how the state/science/industry nexus has advanced the development of technologies that enable commodityism throughout the rest of the 20th and into the 21st century.

Section 4.3: Locking into the Agricultural State/Science/Industry Nexus

In times of environmental crisis, whether they are natural disasters, input shortages, or even the impending climate crisis, capital continues to remain deeply dependent on key features of the state to remain profitable (Parenti 2016). This is particularly the case in agriculture which has built-in barriers to capital accumulation based on nature. The reason for this dependency, according to Parenti (2016: 166-167, emphasis added ??), is because:

...the state does not have a relationship with nature, *it is a relationship with nature* because the web of life and its metabolism- including the economy- exist upon the surface of the earth and because the state is a fundamentally territorial institution... It is the state that delivers nonhuman nature’s use values to capital. More specifically, the modern state’s territoriality *delivers nonhuman nature to capital accumulation by the way of its place-based property regimes, its production of infrastructure, and its scientific and intellectual practices that make nonhuman nature legible and accessible.*

Parenti (2016) calls this notion *geopower*. Just as states in biopower use knowledge to control bodies on a large scale, with geopower, states use their regulatory and knowledge building capacity to control the biosphere (Diran and Traisnel 2019). This state/nature relationship is the

focus of geopower. Without the state, it would not be possible for “Cheap Nature” to exist (Moore 2015). According to Moore (2018: 245):

Capitalists are victims of their own success. To the extent that productivity advances in wide-ranging fashion, input costs rise, and one of two things must occur: boom turns to bust or new sources of supply are found. On a systemic level, however, new sources of supply are not easy to locate and put to work. Capitalists are not well equipped to map, code, survey, quantify and otherwise identify and facilitate new sources of Cheap Nature. If capital is not well suited to do this, the modern state is.

In other words, scientific research, particularly state-funded scientific research, is instrumental in these social-ecological transformations, but primarily as a means to transcend labor/nature barriers as a way to accumulate more capital.

Indeed, the advances in agricultural technology that I discussed above would not have been possible without the assistance of a number of highly specialized scientific disciplines which now fall under the umbrella of “agricultural sciences” (Busch 1980; Busch and Lacy 1983). Agricultural science includes a dizzying array of specializations including agricultural engineering, soil science, animal science, agricultural economics, food science, farm management, and many, many more (Thompson et al. 1991). They practice these specializations within a number of public institutions such as LGUs and regulatory agencies, such as the US Department of Agriculture (USDA), as well as within the private sector as industry scientists.

The *agricultural state/science/industry nexus* describes the historical and contemporary interconnectedness of the state, state funded knowledge producing institutions in the agricultural sciences, and the private industries which sought to use this knowledge to surmount nature/labor barriers to capital accumulation. Throughout the rest of this dissertation, I challenge the hegemonic notion that the private sector has a monopoly on “innovation” by showing how many of the key technologies used by the agricultural industry today were created by state funded institutions both before and after neoliberalization. Indeed, high yield variety seeds, to provide

just one example, were originally developed by scientists at the Agricultural Experiment Station at the University of Connecticut in 1922 (Jenkins 1922). These entanglements between science, the state and industry often make it particularly difficult to understand where “science” stands in relation to industry and the state in the realm of agriculture.

Both of the commodities I discussed above, high variety seeds and ethanol, neatly fit into existing theorization about why these types of highly specialized, technologically advanced commodities emerge during periods of time, particularly when the private sector is facing stalled or declining profitability (Gillon 2016). Drawing from Marx (1973; 1967; 1971), Mann and Dickinson (1978) argue that, far from it being an anomaly, it made sense within the logic of capitalism that it took longer for agriculture to be fully embraced by capitalist development. On the one hand, Marx does note that nature provides surplus value for capitalists in the form of *rents*- or surplus value that is generated through nonhuman labor instead of human labor power. He demonstrated this in *Capital: Volume III* (1971) using the example of a capitalist that owns a waterfall:

To what circumstances does the manufacturer in the present case [owning a waterfall] owe his surplus profit...? In the first instance, to a natural force, the motive force of water-power which is provided by nature itself and is not the product of labor, unlike coal that transforms water into steam, which has value and must be paid an equivalent, i.e. cost something. It is a natural agent of production, and no labor goes into creating it. But this is not all. The manufacturer who operates with the steam engine also applies natural forces which cost him nothing but which make labor more productive, and... increase surplus value and hence profit.

Before the invention of key technologies that pushed these natural boundaries to production and distribution, such as the steam engine, agricultural production was not only grounded in nature, but required substantial amounts of labor. It was not until these nature/labor based barriers to

accumulation were overcome using science and technology that agricultural production became viable as an industry (Gillon 2016; Mann and Dickinson 1978).

The first nature-based barrier to production was simply the long period of time it took to produce an agricultural commodity. Both crops and livestock require long periods of time to produce the end product to sell: crops need to grow and animals need to be raised. According to Marx (1967), there is a difference between the *labor time* and *production time* necessary to produce a commodity. Production time entails two parts. While the first period includes the labor of the producer, the second period is characterized by ‘abandonment’ of the commodity to various natural processes necessary for more commodity production. However, a key function of capitalist production is to gain profitability by shortening both labor and production time as much as possible. As the saying goes, time is money. This “unproductive” production time inherently made agriculture unappealing to capitalist ventures, at least until the late 19th century.

Another nature-based limitation of agriculture to capitalist production were problems of circulation, or the process of getting the commodity to a market to sell. According to Mann and Dickinson (1978: 475):

...the labor invested in the circulation and realization process, while creating no value, is nonetheless necessary for the conversion of one value form to another... Moreover, the expenses of circulation must be paid by the capitalist; consequently, the circulation process entails unavoidable costs for capitalist production.

Risk is inherent to many agricultural commodities because of their ability to expire before reaching the market in the first place, resulting in a loss of profitability. This is particularly true in the case of dairy products, such as milk and cheese, which have the potential to expire quickly without access to some type of refrigeration or dehydration. These commodities, then, according to Marx (1967), were significantly less likely to be incorporated into capitalist production.

However, both of these nature-based barriers to agricultural commodity production can and have been overcome by what Goodman, Sorj, and Wilkensen (1987) identify in their theory of the development of capitalist agriculture as the processes of *appropriationism* and *substitutionism*. In the US, appropriationism of agricultural production occurred in several waves (Gillon 2011a). The first two waves addressed labor. Not only does crop production require a large amount of land, before mechanization it also required substantial amounts of labor. The first wave occurred in the 1790s with the creation of the cotton gin and mechanical plows. Cotton production expanded rapidly because the agricultural labor force of the time, particularly in the Southern US, was free slave labor. Indeed, the creation of the cotton gin actually encouraged the expansion of slavery in the US as plantation owners sought more labor. Between 1790 and 1860 (Bailey 1994: 36):

For each decade...the slave population increased between 25 percent and 33 percent, averaging 28.7 percent over the period. The more rapid increase in the percentage of cotton produced, which was 1500 percent over the same period undoubtedly speaks to the more intense exploitation of slave labor, and the greater fertility of the soil as cotton production shifted and expanded into the black belt of the lower South.

By the mid-1800s, 75 percent of the world's cotton production came from Southern states in the US. In the decades following emancipation, capitalists once again faced problems for capital accumulation in agriculture because much of the system had relied on free labor from enslaved peoples. However, these barriers to production were overcome in the second wave with the creation of the engine. This was a critical turning point in the history of US agriculture because not only did it mark a new age of capital intensive farming through the use of technologies, but it also was the beginning of agriculture's dependency on fossil fuels for food production (Pfeiffer 2006).

After World War II, the nature-based barriers that held agriculture back from becoming fully integrated into capitalism began to be surmounted through the invention of chemical fertilizers and pesticides during the Green Revolution (Glaeser 2010). This was critical for agriculture, considering the end of the 19th century was characterized by a global land-grab among colonizer nations for access to sources of fertilizer (Clark and Foster 2009). Holleman (2018), in her impressive book *Dust Bowls of Empire*, highlighted the importance of recognizing the relationship between imperialism and fertilizer. According to Holleman (2018), “Capitalist agriculturalists addressed the early European soil crisis, caused by the expansion of agricultural production for profit, by seeking to replace the lost nutrients in the soil with fertilizers, rather than rebuilding the soil for its long-term health and fertility,” (100). Incorporating farming practices that increased soil health or setting aside land to reaccumulate nutrients both took time and land away from commodity production. When extensification, in other words, the theft of Indigenous land, was no longer an option, chemical fertilizers enabled farmers to dramatically increase their crop yields while at the same time spending less labor time ensuring that their crops had enough nutrients to grow.

It was not until the 20th century that nature-based barriers to capital accumulation in agriculture were truly surmounted by appropriationism starting with the creation and use of agricultural biotechnologies. The increased use of agricultural biotechnology is associated with, “...accelerating consolidation and small farm loss, creating farmer dependence on multinational corporations, and driving prices down by stimulating overproduction,” (Kitchy et al. 2008: 147). In crop production, the invention of high yield crop varieties, for the first time, shortened the natural production time of staple crops such as corn and wheat (Briggs 2009). Here lies another benefit of appropriationism for capitalists: the creation of industrial inputs as a new stream of

revenue (Goodman, Sorj, and Wilkinson 1987). However, it is important to again highlight that these practices were immensely beneficial for capitalists selling these products but detrimental to the farmers that used them.

For example, high yield variety seeds need to be purchased every year because they do not produce new seeds. The purchase of high yield variety seeds has, on the one hand, enabled farmers to shorten their production time. But on the other hand, farmers incurred a new cost and a new form of dependence on corporations for specific seeds (Richards 1993). Over time, the dominance of industrial agriculture resulted in the displacement of the cultural tradition of seed saving all around the world (Shiva 1993). The creation of high yield variety seeds distinctly disadvantaged peasant farmers, particularly across the Global South, and created immense power imbalances and dependency between small-scale farmers and global agribusinesses (Kyeyune and Turner 2016).

The concept of substitutionism has evolved over time to encompass various different processes within agriculture as the industry has become more technologically advanced. At first, substitutionism referred to new ways of processing food which aimed to substitute industrial inputs for nature-based components of agricultural products in order to either cheapen or speed up production. A classic example of this is margarine. As noted by Gillon (2011b: 408):

Margarine production, for example, entailed a more radical qualitative shift from the rural product butter, but unlike powdered milk, it was not produced as an industrial method of preserving a less stable rural product. Instead, margarine manufacture replaced butter with a product that reduced agriculture's role to the supply of cheap, raw materials (animal fats and then vegetable oils) that could be used interchangeably as market and technical concerns dictated.

These processes of substitutionism became much more common from the 1950s onward as food science became a legitimate scientific discipline within academia.

By the 1980s, Goodman, Sorj, and Wilkinson (1987) began extending the concept of substitutionism. Goodman, Sorj, and Wilkensen (1987) went beyond a focus on food production within agriculture by highlighting how substitutionism could be also understood as central to new strategies of bio-industrialization that “flex” crops from food to fuel. Processes of bio-industrialization involve, “industrial application of genetic engineering to fermentation and enzymatic and other biological processes directed toward the creation of new, proprietary industrial products and technologies,” (Gillion 2016: 123-124). Bio-industrialization opened the door to a whole new range of uses for agricultural products. Substitutionism in this sense uses science and technology not only to make new commodities from existing commodities (such as ethanol from corn), but also to create new streams of revenue from products that were formerly understood as *waste*. In the next two sections, I look at two modern forms of appropriationism and substitutionism to show how neoliberalism encourages these practices further as the state, science, and industry become more deeply intertwined.

Section 4.4: Appropriationism within the State/Science/Industry Nexus: The Case of rbST

While the state/science/industry nexus has been a part of agricultural research institutions since their inception in the 19th century, neoliberalism has only compounded the impacts of these changes as time went on. To quote Reynolds and Szerszynski (2012: 37):

[The] transformation of knowledge generation in the neoliberal period may be described as the privatization of science. However, this is a contradictory process, with limits. Knowledge generation is the accumulated effect of networks of cooperation, collective effort and public institutions... This crucial role of public institutions in generating the knowledge base that private appropriation depends upon underlines the continuing role of the state and public funding. Indeed, the moves mentioned above, such as the reorganization of university-commercial relationships and the legal frameworks supporting intellectual property, formed part of a new state strategy in the neoliberal era.

As I discussed in the last chapter, neoliberalism encourages the deregulation of existing institutions to hollow them out before building them back up using re-regulation. In this section and the next section, I highlight how neoliberalism has impacted the public production of agricultural knowledge in the US. Neoliberalism has had a profound impact on all regulatory agencies, including the USDA, but also LGUs which conduct the bulk of scientific research (70 percent) in the public sector (Nelson and Fuglie 2022).

As soon as we enter the 1980s, we can see how dramatically both public and private sector research was reshaped by neoliberalism. It was during this period that agricultural research became even more geared towards producing knowledge for use in the private sector. For example, the Patent and Trademark Amendment Acts of 1980 and 1984 thrust public research institutions *further* into the free market. These new regulations, as noted by Slaughter and Rhoades (1996: 319):

...gave new and concrete meaning to the phrase 'commodification of knowledge.' The act[s] enabled universities to enter the marketplace and to profit directly when universities held equity positions in companies built around the intellectual property of their faculty as well as to profit indirectly when universities licensed intellectual property to private sector firms.

In 1984, Congress also passed the National Cooperative Research Act. This act had huge implications for research within academic institutions because it deregulated existing antitrust laws to enable researchers at public universities to engage in research with privately owned firms. The National Cooperative Research Act of 1984, in fact, changed how public research was conducted in the US as 'competition in relevant markets' became a more prominent goal for the Reagan administration.

Aside from a sharp dip during the first year of the Reagan administration, funding for agricultural research experienced a steady upward trend between 1981 and when funding peaked

in 2002 (see figure 4.1). Funding for research at the USDA, on the other hand, did not see these increases as it remained relatively stable aside from slight increases and decreases until 2002. After 2002, research funding for both LGUs and the USDA began to decrease. LGUs in particular saw a large decrease in research funding throughout the 2000s. However, when funding from the private sector is taken into account, the story looks a little different. As shown in figure 4.2 below, private funding of agricultural research and development (R&D) surpassed state funding in the 1980s.

The state does not consider it an issue that they did not correspond with their own funding increases because (Heisey 2019):

Public and private agricultural research efforts are often complementary, rather than competitive... The private sector focuses mainly on R&D related to marketable goods and technologies... On the other hand, public-sector research efforts are more likely to be applied to areas with large social benefits, such as environmental protection, nutrition, and food safety.

In other words, the private sector has stepped in to fill the funding gaps left by the state.

Here, we can see another way neoliberalism has deepened the state/science/industry nexus. As I discuss below, the state used re-regulation to encourage the private sector to fund agricultural researchers and faculty members at LGUs themselves. Even if the private sector is funding research, they are relying on the state because this research is being conducted in *state funded labs* using *university trained experts* to create knowledge for use in the private sector. Indeed, why pay to build your own lab and take the time to hire experts when you can use the facilities and experts the state already has at their disposal? In the case of the bovine growth hormone (rbST), university research was not only essential for Monsanto to develop the hormone, but also for it to gain approval by federal agencies later on.

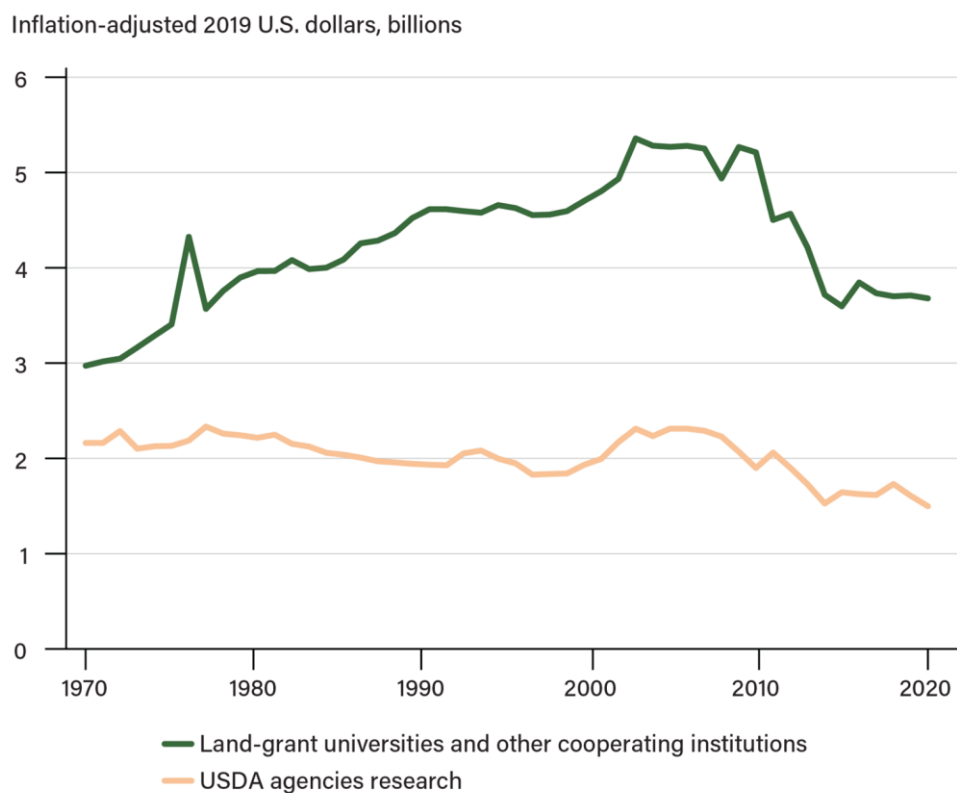


Figure 4.1: Funding for Agricultural Research 1970-2020 (Nelson and Fuglie 2022)

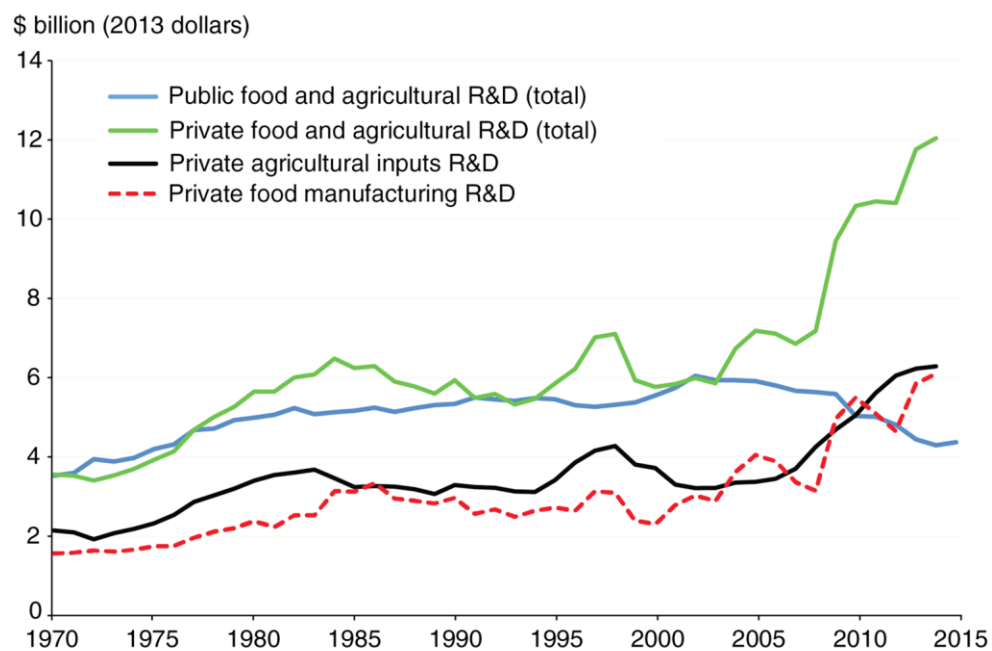


Figure 4.2: Agricultural Research and Development Funding in the US from 1970-2015 (Heisey 2019)

Drawing from Mills (2002), here I highlight the importance of the state/science/industry nexus as it became further intertwined in the latter half of the 20th century using the case of rbST. In their comparative analyses, Mills (2002) compares how regulatory responses differed outside of the US during the debates around regulatory approval of a biotechnology, rbST, created by one of the largest agrochemical companies in the world, Monsanto. rbST, enables dairy cows to produce 10-25 times the amount of milk they could produce naturally. Although several multinational biotechnology corporations were competing to produce a version of rbST, it was Monsanto's version of the drug that first gained approval despite immense contestation from the public. Both Canada and the EU refused to grant regulatory approval to Monsanto's new drug.

Just like ADM, in the 1970s, the companies within the chemical and pharmaceutical industry were also feeling the financial pressure from the oil crisis to expand into new markets (Mills 2002). Monsanto saw this as an opportunity to get into agricultural biotechnology. From the beginning of their journey into biotechnology, Monsanto sought to use the expertise of university researchers in their development. One executive at Monsanto described their relationship this way:

The most important external vehicle for Monsanto's discovery base is the university affiliations they have developed. The university professors have no development costs. All their government grants are pure discovery money. So bang for buck, you have access to some of the finest minds. Monsanto's investment in the university research provides a scientific base, a lead for new discoveries far in excess of the cost of investment (Leonard-Barton and Pisano 1990: 12-13 found in Mills 2002)

In 1974, Monsanto agreed to pay researchers at Harvard University \$21 million if the university agreed to allow the licensing of patents for therapeutic products for profit instead of for public use only. However, by 1975, Monsanto started looking for researchers elsewhere because

Harvard researchers refused to share their findings with scientists at Monsanto until after peer review.

It was clear that Monsanto was seeking a more open relationship with university researchers than Harvard was willing to provide. As a result, they entered a contract with Washington University, a private research university in St. Louis, Missouri. Their agreement stipulated that the university would receive \$23.5 million in funding for their medical school and Monsanto was able to not only have exclusive rights to technology that was patented at the university, but also their scientists could get access to data and other information collected by university researchers. This new relationship was clearly valued by the university as well. Indeed, the quote above is from Dr. Philip Needleman, a professor at Washington University who eventually became vice president of Monsanto by the end of the 1980s.

This can be observed in the decisions of researchers at the University of Wisconsin- a leading land-grant university for agricultural science- at the time. With many researchers and academics being Wisconsinites themselves, they clearly understood the impact that rbST would have on small farmers. However, when the University of Wisconsin decided to work with Monsanto to further develop rbST, they agreed, despite public backlash. According to these scientists, they followed through with this research because they believed that “...research was necessary in order to forestall further decline in the industry as foreign competitors proceeded with technological applications,” (Mills 2002: 41). According to Reynolds and Szerszynski (2012: 37),

It has often been noted that the neoliberal era did not simply see de-regulation and the ‘retreat of the state’ but rather complex forms of re-regulation and the reorganization of the public sphere to be optimized for global competition – a form of state intervention named by Cerny (1990) as a ‘competition state’.

Here we can see how, despite knowing the negative impacts for small farmers (which many of these scientists knew personally), the pressures of neoliberal globalization and remaining competitive in a global dairy marketplace were embedded within the research priorities of public scientific knowledge producing institutions, thus more difficult for scientists to challenge. The invention of rbST was not a response by industry to a crisis of lack of supply, but another means of accumulation by appropriation for Monsanto, a company that was, at the time, struggling to maintain profitability (Mills 2002). In fact, by the time Congress began the debate on the approval of rbST in 1986, dairy overproduction had become a crisis. In fact, overproduction and gluts of dairy products were a general feature of the US dairy industry since at least 1965 and remains a problem to this day (Mills 2002; Lee 2019). By 1988, the federal government had paid over 16 billion dollars to purchase and store the excess dairy products that were produced since 1979 (Mills 2002).

The eventual approval of rbST was not only puzzling because of issues around dairy overproduction, but also because it was strongly contested by farmers around the US. The introduction of rbST was met with hostility from both farmers and farm advocates who claimed that this product would hurt small family farms (Mills 2002). Multiple studies that emerged during this debate highlighted that there would be significant losses to small farmers if rbST was approved (Collier 2000). Small farm groups from states with large numbers of small farms, such as Wisconsin and Vermont, immediately responded by forming coalitions and petitioning their representatives as well as the FDA. On the other hand, the largest farmer organizations in the US, including the AFBF and the National Milk Producers Association, were “notably absent” from any discussion about the implications of rbST. These organizations, according to Browne

(1987), did not see these issues as relevant enough to intervene, once again showing that biases in favor of large-scale production within these institutions remained strong.

Section 4.5: Substitutionism within the Agricultural State/Science/Industry Nexus: The Case of Ethanol

As opposed to the last section that focused on the approval process of a specific technology within the FDA, this section shines a light on the importance of power in the debates leading up to what is known as the “Farm Bill.” It is difficult to overstate the importance of the Farm Bill for the organization and goals of the food system in the US. The Farm Bill includes funding for almost every category related to food agriculture in the US. The 2018 Farm Bill, for example, provided a whopping \$428 billion for conservation programs on farmland, federal farm loan programs, energy production (particularly in the case of biofuels as discussed below), crop insurance, rural development, research, and even nutritional programs such as the Supplemental Nutrition Assistance Program (SNAP) (National Sustainable Agriculture Coalition 2023). The Farm Bill is up for renewal every five years which makes these debates useful for studying political change. The most recent bill was passed in 2018, meaning that agricultural groups are currently fighting to make their interests known for the next Farm Bill which is set to pass sometime in late 2023.

The context of the debate and regulatory approval of rbST revealed that these hormones were a clear case of accumulation by appropriation. The group that stood to benefit the most from rbST was Monsanto and the largest dairy producers. These biotechnologies created to overcome nature-based barriers to capital accumulation were not only contested by the public, but by scientists within the state/science/industry nexus (Mills 2002). However, the rapid

expansion of biofuel production, which occurred two decades after the rbST debates, took place in an entirely different context which *necessitated substitutionism in order to maintain capital accumulation*. Building on the last section which highlighted the importance of the state/science/industry nexus for the approval of the rBST hormone, here, I draw from Lehrer (2009) and Baines (2015) to show how state knowledge producing institutions, in conjunction with strong pressures from agricultural interests, were central to the creation of markets for corn ethanol biofuels in the US despite the unknown economic, social, and environmental consequences surrounding their use. For the first half of this section, I describe the economic conditions that encouraged the private sector to push for the creation of substitutionism technologies followed by the rise of a biofuels industry supported by state research, funding, and infrastructure.

But why biofuels? Why and how did biofuels, specifically ethanol, come to be a key solution to the energy crisis at the time? Biofuel is a fuel derived from biomass. To put it simply, biomass is the organic matter used to make fuel which includes plants (such corn, the most common type of biomass for biofuel, and soy) and animals (manure) (EPA 2022a). The most common type of biofuel is ethanol, a fuel derived from corn. Biofuels are framed as a cost effective, cleaner substitute for gasoline. Between 2002-2011, the US experienced a rapid growth in biofuel production, particularly ethanol production. Since the early 2000s, the biofuels industry has benefited immensely from state programs, sources of funding, research, and infrastructure development (Malcolm, Aillery, and Weinberg 2009). By 2012, ethanol production replaced 6 percent of gasoline used for fuel in the US, yet consumed 42 percent of the corn grown in the US (Koirala et al. 2015). Since that point, about 45% of corn produced in the US

has gone to ethanol production, the second largest source of corn behind animal feed (USDA 2022).

The development of the biofuel industry happened in two waves. The first was the sole project of ADM in the 1970s. Ethanol was ignored as a fuel source for decades until capitalists had a reason to use it- the 1970s fuel crisis (Baines 2015). It was at this point that Archer Daniels Midland (ADM), began aggressively advocating for the use of ethanol as a substitute for petroleum (Baines 2015). During this period, the state/science/industry nexus exploited what Lehrer (2009) refers to as a “policy window” of opportunity, which could also be referred to as a critical juncture, to expand biofuel production in the US. According to Lehrer (2009: 428):

Policy change generally takes place incrementally, as legislators with diverse constituents negotiate compromises among them (Baumgartner and Jones 1993; Bonnen et al. 1996). However, policy can at times change rapidly, as situational, political, and interest group forces converge to produce a policy window, or a new opportunity for change that was previously unachievable... Forces that contribute to a policy window include events that make certain issues seem more important than others, or certain policy alternatives seem more suitable than others at a particular moment in time.

In other words, policy windows are highly contingent and heavily context dependent- they require action at just the right place and time. As one of the largest grain, soy, and corn processing agribusinesses in the world, ADM used the high prices of fuel to put their foot in the door of the fuel industry. ADM also saw the increased use of ethanol as a way to buffer the loss of profits in the winter that resulted from a seasonal decline in the consumption of sodas made with high fructose corn syrup. By 1978, ADM had used their lobbying muscle to procure immense benefits from the state that enabled them to move into fuel production. Specifically, ADM used the state as a means to fund their build up of ethanol production and protect themselves from competition within the market by successfully lobbying for a 40-cent tax exemption on every gallon of ethanol that was combined with gasoline and a 40-cent tariff on

every gallon of ethanol that was imported from Brazil. ADM was essential in pushing the federal government to establish policy early on that eventually benefited ethanol producers later down the road. The second wave occurred in the early 2000s.

As opposed to rbST, the political economic context of the rollout of biofuel production in the early 2000s was a response to a crisis that was slowing down production across all industries including agriculture: the 2000s fuel crisis. Indeed, as noted by researchers at the Agricultural Research Service (ARS) at the USDA, “In some sense, the [biofuel] industry has become accustomed to the nurturing effects of world events,” (Crooks and Dunn 2006: 4). Beginning in 2003, prices for oil rose sharply (Hamilton 2009). These trends continued for several years as the price of oil increased 390 percent by 2008. As a result, during this period, finding more affordable sources of fuel for an economy that was completely dependent on petroleum was a central goal of the state, industry, and the scientific community that supported them.

But the market was not the only thing driving the biofuel boom. Based on interviews with experts, developers, and entrepreneurs in the ethanol industry, a 2006 report from the USDA agricultural Research Service found that economic conditions in conjunction with beneficial state policies were instrumental for the development of the ethanol industry (Crooks and Dunn 2006). In their interviews, a respondent from industry noted: “State and Federal incentives cover a lot of mistakes. They provide a safety net,” (3). State-driven policy was absolutely central to put in motion the development of a new fuel industry as a means to avoid an economic crisis for agricultural producers.

The first piece of legislation to establish funded programs and infrastructure for the biofuel industry was a bill for energy policy: the Energy Policy Act of 2005. The Energy Policy Act created the Renewable Fuel Standard (RFS) program which instituted the requirement that

gasoline-based fuels had to have a certain percentage of renewable fuel (Congressional Research Service 2022). The key types of renewable energy identified in this bill include cellulosic biofuel (fuel created from the woody or fibrous part of plants), total renewable fuel (ethanol created from corn starch), and biomass-based biodiesel (diesel fuels created from animal fats and vegetable oils) (EPA 2022b).

After the establishment of the RFS program, it was clear how agricultural producers could benefit from the assistance that came with government programs. By 2006, the US had produced over 500 million gallons of ethanol and a profit of 5.7 billion dollars (Senate Committee on Energy and Natural Resources 2006). Although the first Farm Bill to mention biofuel development was in 2002, it wasn't until these gains were realized in 2006 that institutions within the agricultural state/science/industry nexus began heavily lobbying to further expand the production of biofuels within agricultural policy (Lehrer 2009). By 2007, only two years after the first program was established, the RFS program was expanded once again, but this time, in ways that gave even more economic benefits to agricultural producers. Not only did the new amendments to the RFS program require the creation of five times more biofuels than the first bill recommended, but also increased the percentage of that amount which were derived from 'advanced biofuels' or fuels created from non-food material such as manure (Lehrer 2009; Congressional Research Service 2022). Here, we can see the beginnings of the biofuel policy window for agriculture during the debates leading up to the passage of the 2008 Farm Bill.

The debates and policies enacted around biofuels between 2006-2008 were unique because of 1) the large coalition of groups, even groups with opposed interests, that came together to support biofuel policy, and 2) the short period of time that it took biofuels to go from relative obscurity to the policy solution for the 2000s energy crisis. Indeed, in an interview with a

representative for an agricultural commodity trade organization during these debates, Lehrer (2009) was told that, “6 months ago, we were kind of talking about ethanol, but nobody was really getting too excited about it. And now ... all we talk about is ethanol... I’ve had three meetings this week alone on ethanol,” (430).

According to Lehrer (2009), during this period, the positive aspects of biofuels were repeated so often by the media, industry representatives, Congress and other representatives, and eventually the public, that they became a “common frame” for understanding biofuels. This common frame consisted of three central arguments. Two of the arguments were economically based and appealed to those who were facing economic uncertainty because of the energy crisis. The first argument framed ethanol as ‘green’ compared to oil because of its energy efficiency, thus reduced cost. As opposed to oil, ethanol had a faster production turnaround because it was derived from renewable resources (such as plants). In the 2008 Farm Bill specifically, another central argument was that biofuel production would provide another source of income to farmers that were already struggling to keep up with the impacts of consolidation and intensification of US agriculture.

The last key argument in favor of expanding ethanol production appealed more to the political context of the time. As noted above, policy windows occur when groups are able to tap into temporal opportunities afforded to them by the political and economic context at the time which makes some solutions more appealing than others. Besides the energy crisis, proponents of biofuels exploited racialized and nationalistic discourses that were used to discuss the War in Iraq. Specifically, proponents claimed that ethanol production in the US would promote ‘national energy security’ and ‘energy independence’ from Middle Eastern oil suppliers (Lehrer 2009).

Because of the political salience of this argument during this time of the Iraq War and in the shadow of 9/11, combined with the economic need from industry and farmers themselves within an already concentrated agricultural industry, these positive arguments for ethanol production overshadowed any discussion of their limitations and consequences within the debate. Some of the largest farm groups at the time, including the AFBF, heavily drew from these discourses.

Along with the common frame which made approval of biofuels seem like a ‘no brainer,’ the political and economic conditions in the short term were highly conducive to the creation of a policy window. In other words, timing was absolutely key for agricultural interests to be able to frame the development of the biofuels industry as an urgent issue that required immense amounts of state funding. Specifically, on top of the 2000s energy crisis and the Iraq War, the debate occurred in the shadow of the Great Recession (Lehrer 2009).

Section 4.6: Conclusion

Although ethanol production did undeniably provide income to some small and medium sized farms, as is the case with agricultural production in general, these policies have disproportionately benefited the largest farms (Wright and Reid 2011). The environmental benefits of ethanol were severely limited (Malcolm, Aillery and Weinberg 2009). While ethanol production does use less oil, the production of ethanol using monocultures comes with another set of negative environmental impacts (Hoekman, Broch and Liu 2018). Expanding the production of corn using conventional techniques of industrial agriculture creates nutrient pollution and eutrophication from fertilizers, pesticide pollution, carbon dioxide emissions from the equipment used within corn production, soil erosion, and loss of local biodiversity to start (Hoekman, Broch and Liu 2018; Malcolm, Aillery and Weinberg 2009).

Overall, the development of the ethanol industry in the US not only funneled more income towards the largest farms in the US and exacerbated existing issues around agricultural pollution from monoculture, but it also created an unintended consequence for livestock producers. Despite the promises made within the biofuel debates, in the almost two decades that the RFS program has operated, biofuels have not significantly displaced oil as a form of fuel (O'Malley and Searle 2021). However, since now over 40 percent of corn and 30 percent of soy in the US are tied to biofuel production, this has resulted in the *the prices of oil and animal feed becoming linked* (Schnepf 2011; Miljkovic, Shaik and Braun 2012; Koirala et al. 2015; O'Malley and Surle 2021). Indeed, for livestock producers, feed represents as much as 60 percent of input costs and corn is the main input used in animal feed in the US (O'Malley and Surle 2021). Koirala et al. (2015: pn) describe these market interactions succinctly using the example of feeder cattle markets:

The recent boom in the corn based ethanol industry has contributed to a subsequent rise in livestock feed prices. As a result, other feed inputs became more attractive and were incorporated in feeding rations. Overall, however, ethanol production from corn increases feed costs for livestock producers, and the causal effect on livestock producers is that they find it hard to remain in the livestock business.

In other words, livestock farmers, who were already paying more for energy inputs, are now required to 1) own or rent more land to grow more corn or other crops used for feed, or 2) purchase new sources of feed. These factors, combined with the deep concentration and intensification that already exists within the livestock industry, have made it difficult for thousands of farmers, even those with large farms, to meet the minimum quantity required to meet the target set by the RFS program. This is particularly the case within the already volatile dairy industry.

As shown in figure 4.3 below, during the first few months of the COVID-19 pandemic, the price of *all classes* of dairy products plummeted, including fluid milk (class 1), soft dairy products such as yogurt and ice cream (class 2), cheeses and whey (class 3), and butter (class 4). However, as figure 4.3 also shows, this drop in prices did not last long (Munch 2022). Around the middle of the period the AFBF identifies as the “COVID-19 Shock,” prices for fluid milk had bounced back to the rate before the pandemic and the price of cheese skyrocketed while the price of soft dairy products and butter remained low. By late Spring in 2021, prices for all of these commodities had pretty much gone back to the prices they were sold for in 2019. But starting in the Fall of 2021, the price of all dairy commodities began increasing dramatically. By March of 2022, the USDA reported that milk prices had reached their highest level in the history of dairy farming, \$25.90, and they continued to rise more after that (National Milk Producers Federation 2022).

Indeed, business seems to be booming for the dairy industry. However, during the same time the price of dairy products was increasing, so was the price of everything else. Russia’s invasion of Ukraine in 2020 resulted in a sharp increase in global fuel prices (Koeze and Krauss 2022). This, in turn, raised the cost of everything else in our fossil fuel dependent agricultural system. When adjusted for inflation, by 2022, fuel prices were at their highest since 2014 and this was combined with already high feed prices driven by the ethanol market. Figure 4.4 (above) shows a breakdown of costs associated with dairy production between 2016-2021 which was calculated using USDA data by the AFBF (Munch 2022). Feed is consistently the largest cost for dairy farmers during this period. Another thing to note is between 2016-2021, there were several points where total expenses for dairy farmers outpaced the amount of profits that the farm was bringing in.

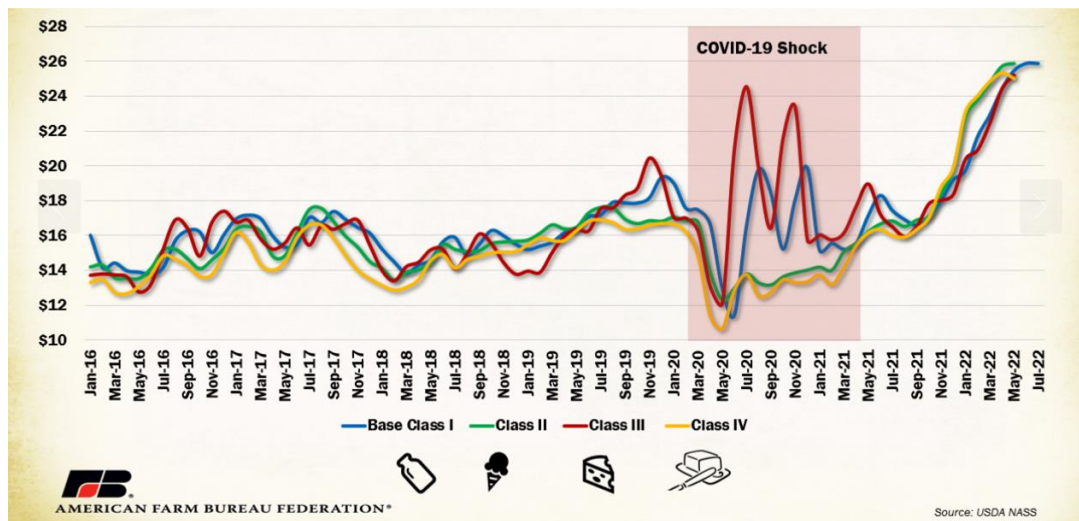


Figure 4.3: Price of Dairy Products in Dollars per Hundredweight 2016-2022 (Munch 2022)

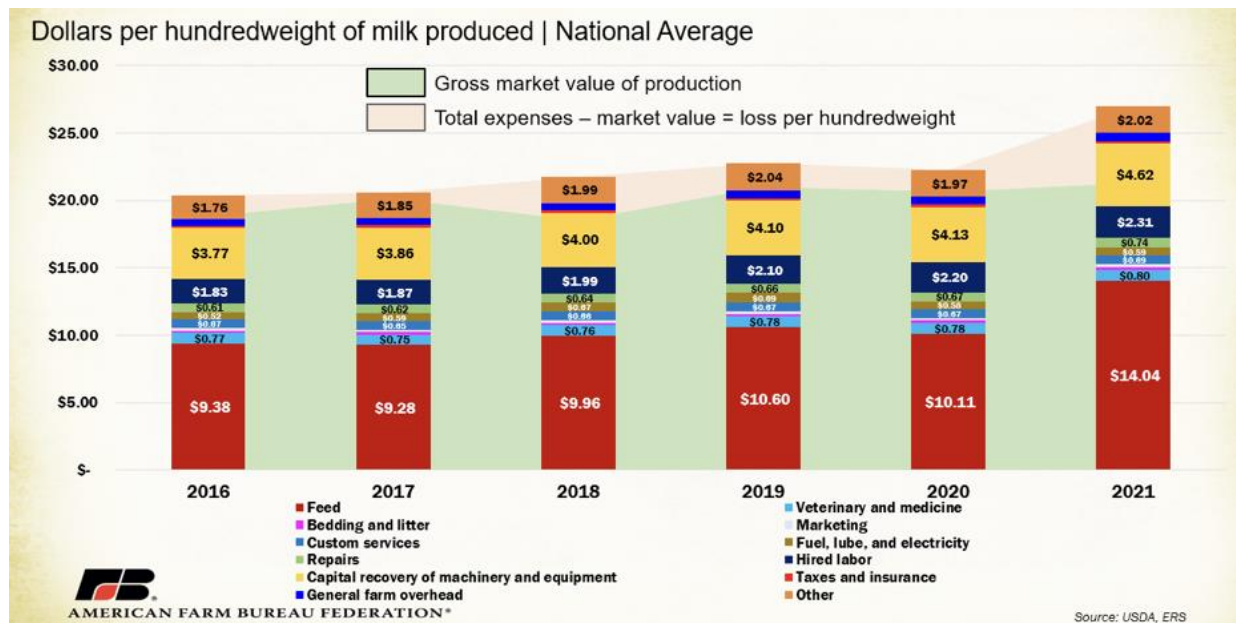


Figure 4.4: Input expenses for dairy production 2016-2021 (Munch 2022)

According to the AFBF (Munch 2022), “In 2021, for each \$27.02/cwt spent, dairy farmers received only \$21.33/cwt, a loss of \$5.69/cwt. This is the largest loss within the timeframe analyzed. Between 2020 and 2021 the loss increased by 233%, going from -\$1.60/cwt to -\$5.69.”

As we saw in the case of ethanol, energy crises play a key role in the adoption of various green technologies, including digesters as I demonstrate in the next chapter. With these high input prices, how can dairy farmers survive? Enter manure digesters.

Chapter 5: Locking-in to Manure Digesters: Tracing the R&D of Digesters within the Agricultural Nexus

Section 5.1: Introduction

Neoliberal policy has increased the marketization and privatization of state functions as well as the use of state facilities for the development of technology within the private sector (Castree 2008; Birch and Siemiatycki 2016). All of these practices increase interaction between the state, industry, and state-funded science. However, these practices also blur the line between regulator, capitalist, and scientist and encourage the development of a revolving door between industry, academia, and the state. I created the concept of the agricultural nexus because in the midst of this research, I often found it very difficult to identify where public sector support stopped and where private sector support began, which is characteristic of neoliberal governance. In the context of digesters, as these new networks formed over time, these actors have coalesced to form what became the digester industry.

Due to the rise of political pressure to create technology as a way to mitigate the impacts of climate change, there has also been a significant amount of research in relation to “lock-in” within the context of what Cecere et. al (2014) refer to as “eco-innovations,” which aim to specifically improve the environment and increase sustainability without changing the problematic conditions associated with our economic system (Oltra and Saint Jean 2009). Many technologies considered to be eco-innovations existed long before they were implemented, but they remained within “technical niches.” These niches are spaces of trial and error where technologies are still being improved and are not expected to immediately conform to the “harsh selection environment” of the market. Indeed, as Cecere et al. (2014) unknowingly highlight in

their discussion of examples of eco-innovations which emerged from technological niches, a majority of the technologies discussed, from hybrid cars to the phasing out of paint products with volatile organic compounds to the creation of solar panels, required state intervention to succeed.

In the first section of this chapter, I draw from archival documents and reports from regulatory agencies within the US federal government including the USDA, EPA, DoD and AgSTAR, scholarly articles, and interviews, particularly my interview with regulator two within the WDNR (2022), to trace the R&D of digesters on farms in the US and Wisconsin. Whether through the funding of research or the construction of costly infrastructure, the creation of green technologies in particular seems to necessitate some type of state involvement. Indeed, the digester industry was on the verge of death many times before it was brought back to life by government funding *and* favorable policy concessions. As I discussed in chapter 4, the development of biofuel, also called “agrifuel,” infrastructure in the US was not exclusively a project of “greening fuel,” but rather a coordinated effort on the part of the agricultural industry to simultaneously address declining profitability of corn in food products and a sharp rise in input costs for farmers by shifting many of these costs onto the state (Baines 2015). Comparably, the rise of anaerobic digestion on dairy CAFOs did not magically appear out of the blue but was built up by state knowledge producing institutions, particularly AgSTAR.

But it is important to mention that digesters are also framed as a solution for a variety of other problems that have less to do with the market, and more to do with the environmental injustices that are inherent to CAFO production. Throughout the history of digesters, they were framed almost exclusively in two ways: as a source of energy and electricity or a way to reduce odors and quell conflicts that were related to urban sprawl. Digesters as a form of odor reduction were consistently offered as a potential solution for farmers who were either already running a

CAFO or sought to expand their farm into one. Here, we can see that conflict with rural communities over environmental injustices stemming from CAFO production was already brewing in the 1970s. By 1979, states began adopting right to farm (RTF) laws, which limited the ability of rural neighbors to sue CAFOs (Centner 2006; Ashwood et al. 2019).

By the 1990s, despite these laws, concerns around rural conflict had not subsided. According to the first edition of “AgSTAR Digest,” a report released by AgSTAR every year since that provides information and “state of the field” updates for digester technology (AgSTAR 1996: 2):

Manure-related odors have been attracting a great deal of attention over the past few years, pitting the public against the livestock producers. While the detection of odor from livestock facilities varies from nose to nose, there is considerable concern in some parts of the country that manure-related odors will intensify with the continued trend toward larger confined operations. In addition, many believe that increased complaints regarding livestock odors are inevitable as more people move to the country from cities to suburbs.

Although this was not necessarily a concern for farmers at the time, regulators and experts on the state level, as well as academics, also saw potential for digesters to reduce harmful GHGs as scientists were just beginning to acknowledge the existence of climate change and the role of methane in warming up the planet (Thornton 1978; Jewell et al. 1980). In other words, the framing of digesters as a source of revenue, a source of green energy, a way to reduce conflicts over environmental injustices, and even a climate solution is not new. These claims have been circulating around digesters for over 60 years.

In the last section of this chapter, I show that proponents of digesters often obfuscate the potential negative health consequences of the widespread use of digesters on CAFOs near rural communities by re-directing focus to their purported climate impacts. Even after all of these years of research on digesters, their health impacts are relatively unknown since there are so few digesters operational on real farms outside of controlled environments and the research itself was

focused on getting these machines to work, not analyzing their impacts (Zheng et al. 2019; Burke et al. 2018). Despite the increased use of the language of environmental justice (EJ) within state climate change mitigation proposals (White House Office of Domestic Climate Policy 2021), digesters do little to address EJ concerns. When the history of digester development and their adoption by large, weakly regulated farms are taken into account, the purported benefits are dubious. Moreover, as I discuss in the last section of this chapter, the lack of research on public health impacts of digesters indicates that these technologies have been used to end the conversation around environmental inequalities. The result is the continued expansion of large scale animal production without any effort to meaningfully address community concerns around pollution. In the realm of green technologies, particularly when it comes to climate solutions, the perspective from rural communities who will be the most impacted by the unintended consequences of the widespread adoption of these uncertain technologies, appear to be overlooked.

Section 5.2: Left in the Dust: Rural Communities, Environmental Inequality, and CAFOs

Over the past three decades, environmental justice advocates, public health experts, and communities living with CAFO pollution have understood that CAFOs emit much more than methane and carbon dioxide (Son, Miranda, and Bell 2021; Wing and Wolf 2000). CAFOs release various pollutants into the air (particulate matter, ammonia, nitrous oxides, and volatile organic compounds) as well as water (nitrates and pathogens) in ways that produce environmental inequalities for rural communities. In many communities across the US, locals still receive all of their water for drinking, bathing, and other everyday activities from unregulated wells that draw from sources of groundwater. The US Geological Service (2019)

estimates that 15 percent of the US population, or 43 million people, depend on groundwater for their only source of drinking water and a significant portion of these communities are in rural areas. According to the Wisconsin Department of Health and Human Services (2022), 30 percent of Wisconsinites use private wells. This is a central dimension of rurality that deserves attention within the environmental justice literature as suggested by Pellow (2016).

Runoff from CAFOs contains harmful nutrients, but also heavy metals such as copper and zinc, animal hormones, pathogens and veterinary grade pharmaceuticals (Burkholder et al. 2007). Most of these substances are shown to also have negative effects on human health particularly for the people that live around and work on these farms. Agricultural runoff can contain trace amounts of veterinary pharmaceuticals such as antibiotics, for example, which are given to animals in a CAFO on a regular basis. Over time, however, this has resulted in various pathogens that are typically found in manure, such as *E. coli*, to become resistant to antibiotics (West et al. 2011). If someone is exposed to a strain of *E. coli* that is resistant to antibiotics, it takes longer to treat and heal the infection and carries an increased risk of mortality. Aside from *E. coli*, agricultural runoff contains other types of bacteria, pathogens, and parasites that can seriously affect human health. To give a Wisconsin specific example, in Milwaukee in 1993, at least 100 residents died and 400,000 suddenly became ill after exposure to cryptosporidium, a type of parasite typically found in waste from dairy cows (Davis, Mac Kenzie, and Addiss 2009).

According to a recent study analyzing the impacts of agricultural air pollution on human health, Domingo et. al. (2021:1) found that:

Agricultural production in the United States results in 17,900 annual air quality–related deaths, 15,900 of which are from food production. Of those, 80% are attributable to animal-based foods, both directly from animal production and indirectly from growing animal feed.

Most of these deaths can be attributed to people breathing in particulate matter. Particulate matter (PM10) is made up of dust particles and other suspended matter connected to livestock production (Agency for Toxic Substances and Disease Registry 2014). Studies of people that worked inside of CAFOs indicated that at least a third of these particles were capable of being breathed in and eventually settling into the lungs of people that are exposed (Bongers et al. 1987). Exposure to particulate matter is linked to diseases that manifest in declined lung function such as bronchitis and asthma. Indeed, there is a substantial amount of literature in public health about the connection between living near a CAFO and asthma rates (Mechant et al 2005; Heederik et al. 2007). In Wisconsin, surveys of rural residents showed that living near a CAFO was associated with lower lung function and high asthma rates within 4 miles of a dairy CAFO (Schultz et al. 2019). Similar results have been reported in North Carolina, particularly around low income and minority communities (Wing and Wolf 2000).

Smaller particles (known as fine-particle matter or PM2.5) can actually be absorbed into the lungs. According to Agency for Toxic Substances and Disease Registry (2014):

Several recently published community epidemiologic studies associated adverse effects when PM2.5 formed a significant portion of the particulate exposure, even though PM10, air concentrations were below [national ambient air quality standards]. Medication use, hospital admissions, and the number of emergency room visits (seen primarily with elderly patients and individuals with cardiopulmonary disease) increased under those conditions.

This is particularly concerning when the demographics of rural communities are taken into account. Rural communities, throughout the history of the US, have always had more spaces of concentrated poverty than metropolitan areas and this remains the case today (Thiede, Kim, and Valasik 2017). But additionally, over the last several decades, more working-age populations have left rural areas while older people have stayed behind. This was highlighted in the most

recent Census of rural counties in the US which noted that, “In 2021, people 65 years and older made up more than 20 percent of the non-metro population for the first time in U.S. census history, up from 16 percent in 2010,” (Davis et al. 2022: 3). In other words, exposure of rural populations to particulate matter can be doubly harmful because it is not only more likely to negatively affect older residents, but it also results in the necessity of medical care, which, at least in the US, does not often come cheap.

Ammonia is another air pollutant produced by CAFOs that has harmful effects on human health. Agriculture is the largest contributor to ammonia emissions in the US (Behira et al. 2010) with older studies estimating that the industry was responsible for upwards of 85 percent of US ammonia emissions (National Oceanic and Atmospheric Administration 2000). Ammonia is released from manure as it decomposes in storage, on fields, and in manure lagoons. Exposure to ammonia differs based on the quantity of pollutants people are exposed to. As highlighted by the Agency for Toxic Substances and Disease Registry’s assessment of the toxicity of ammonia (2004: 15):

Chronic occupational exposure to low levels of airborne ammonia (<25 ppm) had little effect on pulmonary function or odor sensitivity in workers at some factories, but studies of farmers exposed to ammonia and other pollutants in livestock buildings indicated an association between exposure to pollutants, including ammonia, and an increase in respiratory symptoms (such as bronchial reactivity/hyperresponsiveness, inflammation, cough, wheezing, or shortness of breath) and/or a decrease in lung function parameters.

Ammonia exposure at moderate concentrations (50-150 ppm) impact the lungs further. High levels of ammonia (over 150 ppm) can result in permanent damage to the respiratory system and the heart. Because ammonia can be rapidly absorbed into the bloodstream, exposure to large bursts of ammonia between 2,500–4,500 ppm can be fatal to humans within 30 minutes.

The most concerning aspect of ammonia is its ability to evaporate into the atmosphere and accelerate the creation of fine particulate matter (Holly et al. 2017). The impacts of ammonia pollution, as shown in the San Joaquin Valley in California, a hub for industrial dairy production and another site of environmental racism (Flores-Landeros et al. 2022). The San Joaquin Valley has some of the worst air pollution in the US which is caused by a combination of pollution from cars, fertilizer, and manure. In Kern County, California, emissions from particulate matter rise to unsafe levels, even for healthy adults, for at least 40 days of the year (Borrell 2018). In the San Joaquin Valley alone, air pollution contributes to at least 1200 premature deaths per year (California Air Resources Board 2019) with other studies estimating rates that are much higher (12,000-2600 people per year according to Wang et al. 2019).

CAFOs, unsurprisingly due to the quantity of manure, are also associated with odors that neighbors have described as unbearable (Kolbe 2013). These facilities, particularly in the summer, produce powerful odors that permeate homes within the community, resulting in fly and rodent infestations, negative health impacts, and overall decline in quality of life. When researchers at Iowa State University and the University of Iowa (2002) measured the emissions from CAFOs to understand the source of these smells, they found that CAFOs release a number of gasses such as hydrogen sulfide, which smells like rotten eggs, and organic compounds such as skatole, a chemical found in animal feces that smells like raw waste. The study was one of the first comprehensive studies on the state-level to investigate public health issues around CAFOs. Interestingly, it was commissioned by the governor at the time, Tom Vilsack, who eventually became the Secretary of the USDA in 2009 and is currently serving his second term in the Biden Administration (Iowa State University and The University of Iowa Study Group 2002). After the study was completed, both teams of researchers unanimously agreed that regulatory action

needed to be taken in relation to ammonia, hydrogen sulfide, and odors. However, they did not know what to recommend for odors because there was not enough research at the time for the working group to *know how* to regulate odors. Still, they recognized that there is a limit to the strength of a smell that a person can take. According to the study (Iowa State University and The University of Iowa Study Group 2002: 150):

Lasley's Iowa Farm and Rural Life Poll (1998) shows substantial concern among Iowa farmers about hog odors. In the 1992 and 1998 polls, respondents were asked "how many days per year they would be willing to tolerate odors from a neighbor's livestock operation before they would consider it a major nuisance." Fourteen percent were unwilling to tolerate more than two days; 34% were willing to tolerate only a week or less, and fully 50% would view odors as a major nuisance if they affected them as many as ten days out of the year. The latter figure rose from 44% in 1992 (Lasley, 1995).

Here, we can see that it was not just rural communities impacted, but other farmers within the community as well. This was not necessarily a farmer versus community issue as it often seems. Indeed, as I discuss throughout this chapter, CAFOs have been spurring conflicts with rural neighbors, which include farmers, for over 50 years. In the next section, I elaborate further on these conflicts which, ultimately, was one central driver of the development of digesters on CAFOs throughout the US.

Section 5.3: Tracing the R&D of Digesters within the Agricultural State/Science/Industry Nexus

When conducting interviews with regulators in Wisconsin in June of 2022, I had a discussion with one regulator that made me question my assumption about the existence of a state/science/industry nexus in the case of digesters. When I asked about university involvement in digester research and design, the regulator responded, "I wouldn't say that the university like develops technologies for digesters. I mean, that's more coming from private sector," (Personal communication 2022). I was unsure about my hypothesis about the nexus for a while after this

interview until I found a digester development handbook by Lusk and published by the Department of Energy (Lusk 1998) which highlighted that the initial research that made manure digesters operational happened at land-grant universities around the US. If the research was not conducted within these spaces, there were researchers and experts from land-grant universities on the farm using their experience to make these technologies work.

Scientists have been experimenting with digesters as a way to produce energy and manage waste since the 19th century (Klinkner 2014). Countries across Asia and Europe, for example, adopted small, community-scale digesters as waste treatment systems for human, animal, and food waste (Abbasi et al. 2012). Countries within Europe, particularly Germany, have steadily increased their usage of large digesters in the 1990s as a way to manage pollution from landfills as consumption increased and methane fumes from decomposition raised environmental concerns (Klinkner 2014). Germany currently has over 4000 operational digesters (Thrän et al. 2020). In the US, however, adoption of digesters has been slower in all sectors because the small-scale digesters that existed in Asia and Europe at the time were not enough to handle the quantity of waste that needed to be processed within industries in the US (Lusk 1998). Digesters are part of a larger “green” industry related to waste disposal which includes, “composting, organics recycling, anaerobic digestion and biogas,” (*Biocycle* 2023). Most digesters that are operational today are used either for treatment of wastewater at treatment plants (1,269 digesters) or to reduce methane in landfills (645 digesters) (American Biogas Council 2023). Manure digesters on farms are still relatively rare. There are two million farms in the US and only 322 operational digesters on farms (USDA 2023; AgStar 2022b).

The Lusk handbook was an important data point in process tracing because it was written in 1998: 4 years after the establishment of AgSTAR, 3 decades after research on digesters began

within the USDA and land-grant universities, and before marketized programs such as LCFS, cap and trade, and RFS even existed. The RFS program, which opened the door to incorporating biogas into vehicle fuel as a means to lower its carbon intensity, did not begin until 2005. California's programs did not start until 2012 (Purdon, Houle, and Lachapelle 2014). In 1998, the only ways for CAFOs to benefit economically were by using the electricity generated during the digestion process to power the farm or selling the digestate from the process as fertilizer. These practices were mostly used to recoup the investment made to purchase and operate the digester and to save on input costs related to energy and fertilizer (Lusk 1998).

In order to highlight the role of the state/science/industry nexus in the creation of manure digesters in the US, I find it useful to trace the development of the most common types of digesters on farms today: covered- lagoon (38%), plug flow (29.6%), and complete mix (27.8%) (AgSTAR 2020). According to Lusk (1998), the first on-farm manure digester in the US became operational in 1972 on a swine farm in Iowa by Harold "Wiz" McCabe with help from Extension Service agents at Iowa State University (Ernst et al. 1999). Lusk (1998) cites this as the first example of an operational complete-mix digester in the US. Complete-mix digesters often look like large circular containers, but they can also be built underneath the farm, which was the case for the first complete-mix digester as shown in figure 5.1 (AgSTAR 2020; Lusk 1998). In these machines, manure is added and mixed together at high temperatures within the digester which then traps the gasses that are produced.

This digester was unique in that it was created from scratch by a small group on the actual farm it was meant to be operated on instead of a prototype built in a controlled setting. Three decades later in 1999, this was still the only manure digester that was operational in the state of Iowa (Ernst et al. 1999). In retrospect, agricultural economists at Iowa State observed



Figure 5.1: Harold “Wiz” McCabe next to the entrance of the first complete-mix digester (Lusk 1998).

that, “The technology was frequently concluded to be a promising idea, but only technically and economically feasible to those who were willing to spend a great deal of time tinkering with the technology on the farm,” (Ernst et al. 1999: 1). But it was not only an issue of time. The way Lusk (1998) describes the creation of the complete-mix digester makes it seem like McCabe threw it together in an act of mad genius:

‘Wiz’ was an innovator and master mechanic, and he took a crash course in the design and construction of a complete-mix anaerobic digester. It took 2 years to locate and install the reactor, fabricate heat exchangers from old dairy equipment, convert an old dairy 10-horsepower upright boiler to operate on both biogas and propane, install the necessary control and safety equipment, and put all the pieces together.

Here, I began to see discourses of “innovation,” of randomly gifted “wiz” entrepreneurs who work with what they have and use their ingenuity to create the technology of the future.

However, not only did this project require the assistance of Extension Services from the local university, but it also cost McCabe \$120,000 in 1972 (Ernst et al. 1999). Those costs come out to \$863,655.50 today. In other words, McCabe’s investment would not be possible for a small farmer struggling to maintain his way of life. He was a CAFO owner with substantial funds at his disposal who was seeking to use this technology to stay in business in the face of mounting criticism about the environmental problems created by CAFOs.

Before state-led, market-based programs were put in place in the early 2000s, the revenue that could be generated from digesters producing heat and electricity was not substantial. Although the CAFO can avoid some costs, particularly during periods of high energy prices, there were no programs at the time that provided financial assistance for digesters. Overall, the costs of the digester were so high that any money that was saved went right into paying for the digester itself. For some of the largest CAFO owners, they saw this as the cost of remaining in business. According to Lusk (1998: 12):

Moreover, without the environmental benefits provided by AD technology, some might have been forced out of livestock production. AD is sometimes the only technology that allows growth in the livestock production business. Turning a waste liability into a profit center that generates annual revenues can moderate the impacts of declining commodity prices and diversify farm income.

In other words, before AgSTAR stepped in to help farmers with the costs and kinks related to digesters in the mid to late 1990s, for farmers like McCabe who had already invested immense amounts of money into industrial swine production, digesters were primarily used as ways for farmers to protect their investments and maintain growth by quelling environmental problems (particularly odors) in the face of urban sprawl during the 1970s. Indeed, this is what pushed McCabe to start his experiments with digesters.

McCabe converted his hog farm into a hog CAFO in 1968 (Ernst et al. 1999).

Immediately after the CAFO began operations, he began receiving complaints from several of the businesses within the neighboring town of Mount Pleasant, including a motel and a family restaurant. The following year, McCabe installed an aeration system in the CAFO's manure lagoon as a way to lessen the odor of more than 1400 hogs in one place. However, this technology did not stop the complaints from neighbors who were, "still not entirely pleased with the way things smelled in Mount Pleasant," (3). It was at that point that McCabe, with Extension agents from Iowa State University decided to start developing an on-farm digester system. As mentioned above, this process took about two years and the digester was operational by 1972.

While McCabe chose to address community conflict with technology, others took a different route by encouraging the passage of right to farm (RTF) statutes in states across the country less than a decade after McCabe's installation (Malanson 2019). RTF law overrides lawsuits from local communities based on property law (Centner 2000). The concept of a nuisance applies when, "there is substantial harm to public health or welfare (public nuisance) or

some kind of unreasonable or substantial interference with people's use or enjoyment of their property (private nuisance),” (Ashwood et. al 2019). Nuisance law recognizes that people use land for more than a commodity. As I described in chapter 3, environmental law has not figured out how to deal with the CAFO problem. As CAFOs started emerging across the US and environmental regulations were not being enforced, rural communities turned to using nuisance law, which is connected to property law, to protect the water sources they depended on.

From the first time I came across RTF laws, at least in Wisconsin, I noticed that the discourses used by farmers and politicians were very different from how RTF laws operated in practice. As it turns out, this was not limited to Wisconsin. The 1970s were a period when CAFOs started emerging all over the country (Malanson 2019). The dominant narrative is as follows: RTF laws are necessary to protect farmers from “frivolous lawsuits” from new rural residents that were not used to farm conditions such as odor, dust, and water pollution involved in farm work (Hansen 2002). As a rural sociologist from the University of Wisconsin Extension Service quoted (*Fond Du Lac Commonwealth Reporter* 1982), “What does a farmer do when city people build homes on lots all around him and then sue him because his tractor makes too much noise when they want to sleep or their livestock cause an offensive odor?” The farmer is just someone who wants to do their job, but is interrupted by the interlocker, who is not even from the community. Must be a radical environmentalist.

However, in tracing the origins of RTF, it seems as if a law which was designed to protect everyday farmers from corporate development was being used to expand another type of corporate development: large farms, specifically CAFOs. Going back to the origins of RTF law, it seems clear that CAFOs were involved from the very beginning. The case that prompted a wave of RTF laws across the US was between a beef CAFO and a real estate developer in

Arizona in the 1960s (Malanson 2019). In this case, the developer, Del Webb, started purchasing large tracts of land in Maricopa County, Arizona, which turned out to be located next to Spur Industries, a feedlot with over 20,000 cattle. This had a devastating impact on the property values for new developments near the feedlot with potential buyers worried about the smells, infestations, and health impacts of the CAFO nearby. When the case made its way to the Arizona Supreme Court, the Court decided that ultimately the CAFO was a nuisance, but Webb knew that when he started developing. According to the Arizona Supreme Court (Malanson 2019: 1580):

Even though the court ordered Spur to move its operations, it recognized that Spur was not at fault. Webb knew of the area's agricultural character when he started building... Recognizing both the public's need for relief and Webb's role in creating the problem, the Arizona Supreme Court ordered Webb to indemnify Spur for its costs of moving or shutting down.

This case was settled in 1972. In 1979, North Carolina, another CAFO-heavy state, became the first to pass an RTF law (Smart 2015). Many of these laws became increasingly restrictive towards rural communities as time went on (Ashwood et al. 2019; Centner 2006).

Wisconsin passed a similar law in 1982 in response to a lawsuit against a 16,000 laying hen CAFO. Chicken CAFOs were rare at the time in Wisconsin. In 1981, the Wisconsin Supreme Court ruled that the CAFO was a nuisance (Hansen 2002). But in this case, the petitioners were not urban residents moving to the countryside, unaware of the scents and sounds or real estate developers. In reality, the egg CAFO was challenged by rural communities composed of many farmers, after decades of unresolved water pollution. The CAFO was not only leaking waste into their water sources, but was mishandling waste in a facility adjacent to local schools. Many people within the community lived on those farms for generations before the egg farm grew into a CAFO. The legislature passed the RTF law less than four months later. But interestingly, when the law was established, proponents in Wisconsin were using the same

arguments as proponents in Arizona even though the impacted communities were not property developments. Here, we can begin to see the friction between states and the agricultural industry on one side, and rural communities on the other. This friction played out in courts across the US between the 1970s-1990s, the key period for CAFO development.

The timing of research, development, and adoption of digesters also correspond to various fuel crises, which is often the case with alternative fuels such as ethanol and natural gas (Carolan 2009; Wang and Krupnick 2015). Indeed, whenever digester research was mentioned in the context of the 1970s, discussion of the oil crisis typically followed (Mattocks and Wilson 2005; Lusk 1998;) As the oil crisis deepened throughout the 1970s, the first digester “boom” followed as the nexus worked to enact substitutionism to avoid the rising costs of inputs related to agricultural production. The state’s job was to experiment with the design of digesters in order to bring down their exorbitantly high costs and keep them from constantly breaking down. In the case of the complete-mix digester, researchers at Cornell were finally able to simplify the design and somewhat reduce the costs of operation by 1978 (Jewell et al. 1978).

In 1979, the first digester was installed at a commercial farm, Mason Dixon Farms in Gettysburg, Pennsylvania (Lusk 1998; Goldstein 2009; Mattocks and Wilson 2005). This time, it was a plug-flow digester. Plug-flow digesters are long concrete lined ditches that are built into the surface of the ground (AgSTAR 2020). Each day, operators fill the digester with a new “plug” of manure which then pushes existing manure further into the digester to decompose. It releases gas over time and the gas is trapped by a cover on top of the machine to be used for energy later on. After consulting other sources, I recognized that some crucial details were left out of Lusk’s history of digester R&D. In the description of the plug-flow digester that operated

on the farm, there was no mention of who participated in the development. This omission gave the impression that the farm itself, like McCabe farms, was leading the charge.

To gain more insight about the industry side of R&D, I drew from *Biocycle*, a journal of the recycling industry that has covered technologies such as digesters since 1960. In 2009, *Biocycle* took a look back at their coverage of manure digesters through the years (Goldstein 2009). In their March/April 1980 issue, *Biocycle* offered a much more detailed description of how the digester on Mason Dixon Farms came about. They highlighted all of the actors involved in its development which included the CAFO, but also a private engineering firm from Chicago, Sheaffer and Roland, who acted as the digester developer. The agricultural engineer hired by Sheaffer and Roland was Mark Moser, who had recently finished graduate school at Cornell University where he worked as a research assistant for Professor Bill Jewel. Again, this highlights that Cornell University was a key site for knowledge production for digesters.

According to Moser (Goldstein 2009):

As a term assignment, Dr. Jewel gave us his gear – two Lucite tube digesters –and gave us the operating parameters. It gave me experience working with farm digestion and animal waste management. I supervised the start-up of the Mason-Dixon installation, and then did the troubleshooting because there was trouble to be shot.

From this, we can begin to see how small the world of digesters actually was at the time. Although Mason-Dixon farms was not explicitly a USDA project, it still necessitated the assistance of agricultural engineers trained on and working with land-grant universities.

The last type, the covered lagoon digester, was partially constructed in 1982 by the California Energy Commission (CEC), a state regulatory agency that was established explicitly as a response to the 1970s fuel crisis to conduct R&D on new technologies that could reduce the cost of energy (Lusk 1998; California Energy Commission 2023). On a hog farm with over 1600

hogs in Tulare, California, the CEC attempted to create a floating cover over a large manure lagoon, but could only cover part of the lagoon system. A covered lagoon digester, as its name suggests, is pretty straightforward. A cover is installed over the lagoon, the methane is trapped within it, and a vacuum collects the biogas as it forms (AgSTAR 2020).

By the late 1970s and early 1980s, there seemed to be some type of disconnect in that actors from industry and academia were significantly more optimistic about the environmental and economic potential of digesters than researchers within the USDA. In 1978, the National Economic Analysis Division of the USDA released a report entitled “An Assessment of Anaerobic Digestion in US Agriculture.” This report evaluated the feasibility of farms adopting digesters as they existed at the time, and including the digesters spearheaded by Jewell at Cornell. Overall, they did not see much to get excited about (Thornton 1978: 5)

Although the process has been advocated as a source of fuel, feed, and fertilizer, its widespread adoption in American agriculture is doubtful. The cost and complexity of most digestive systems make them difficult to incorporate in agricultural operations. Although site specific applications may be feasible, these will not have a major impact on the agricultural sector. As a source of energy, there is little possibility of anaerobic digestion providing even a small percentage of national energy requirements.

Indeed, the prototypes of the 1970s digester boom were almost entirely failures. As highlighted by Mattocks and Wilson (2005):

Of the 140 or so digesters constructed during the 1970s renewable energy “hay day”, less than half were actual production facilities, with the remainder in research facilities. One firm constructed 20 facilities, all of which failed. Of all the systems built during that period, about 85 percent failed or were otherwise taken out of service.

Despite the many failures experienced by early digester developers, actors within industry and academia were still optimistic. One digester developer recalled to Biocycle, “...the early 1980s [was a] time that, *‘we made farmers believe – we convinced them – that their manure was gold,’* he says. *‘It was the future energy source of America,’*” (Goldstein 2009 emphasis added). During

this period, digesters could not only save money for farmers, but generate income as several states created programs to pay farmers between 8 to 9 cents/kwh for the electricity it created. However, as I discuss further below, when these programs ended, farmers had significantly less incentive to use these incredibly expensive and time consuming machines, even if they offered environmental benefits for their neighbors.

The first full scale covered lagoon digester was not operational until 1988 in North Carolina (Lusk 1998). Although the digester energy boom had become a bust as oil prices and funding for renewable energy declined in the late 1980s, digesters were still understood as a worthwhile investment in North Carolina where there are massive hog farms and long standing disputes with neighbors, particularly in Duplin County (Mattocks and Wilson 2005; Wing and Wolf 2000). This digester was constructed on a privately owned farm, Randleigh Dairy, by researchers from North Carolina State University and the North Carolina Energy Division, an office within the NC Department of Environmental Quality (Safley and Lusk 1990).

As I have shown so far, all three of the most common types of manure digesters operating on CAFOs in the US today were created partially or entirely by state-funded research institutions or researchers that came from these institutions. These actors were actively seeking to create a network/nexus of scientists, regulators, and entrepreneurs in order to foster the development of a new digester industry. A valuable dimension of my concept of the agricultural nexus comes from the way it highlights the importance of proximity- these groups, due to the neoliberal re-organization of the state, work closer than they ever did before. As the state started encouraging PPPs, this enabled the private sector to gain inside insight into the way the state regulates as they worked with regulators and even took over some regulatory capabilities. Similarly, research

policies and programs at universities, as I explained in chapter 3 and 4, have encouraged the strengthening of the nexus as the private sector, the state, and scientists work together.

Over time, as I also discussed in the case of Moser, many scientists from within academia began to enter the private sector as consultants, a practice similar to the behavior demonstrated by crop consultants during the same period (Wolf 1996; 1997). As was highlighted by Wolf in his analysis as well, these practices blur the line between regulator, capitalist, and scientist and normalize and encourage the development of a revolving door between industry, academia, and the state. To give an example closer to the heart of this dissertation, in the Lusk report, when he mentioned the digester created by NC State University, he cited a report that he co-wrote with Dr. L.M. Safley Jr. (Safley and Lusk 1990), who, at the time, was also an agricultural engineer at NC State University. At the end of the Lusk report, he provided a contact list of existing digester design companies. The second contact on that list was Dr. L.M. Safley Jr., who in 1998 was CEO of AgriWaste Industries (Lusk 1998). This was quite surprising to me considering I was very familiar with this consultant. In fact, I had attempted (unsuccessfully, as I discuss in the next chapter) to set up an interview with engineers working there during the same time I was conducting interviews with Wisconsin regulators. AgriWaste was one of the project verifiers when Central Sands had hundreds of carbon offset credits invalidated by the California Air Resources Board for failing to comply with local environmental regulations.

According to *BioCycle*, “Government financial support for digestion ended, energy production was the main goal of digesters and energy remained cheap. Very few digesters were constructed in North America between 1985 and 1995,” (Mattocks and Wilson 2005). But what happened in 1995? After facing an increased level of pressure during the recent rounds of meetings at the Rio Earth Summit in 1992, between 1993-1995, the Clinton-Gore administration

passed legislation that created several programs aimed at increasing “the spirit of collaboration to the monumental problem of our warming planet” with the private sector while also, “proving that if the government empowered businesses to protect the environment at a profit, it would find a powerful partner in the fight against climate change” (EPA 2021). These included the many “star” programs aimed at making slight “green” changes to existing technologies and industries including the ENERGY STAR, Natural Gas STAR, as well as the AgSTAR program, which was created in 1994 (EPA 2021). By 1995, AgSTAR was up and running.

The creation of AgSTAR was absolutely essential to foster the digester industry that exists today. AgSTAR acted as a nationwide program to build up the digester industry across various states. One of the most impactful programs carried out by AgSTAR started in 1996 with the creation of “Charter Farms.” They would partner with privately owned CAFOs that were seeking financial and/or technical assistance with digester technologies. As of the fall of 1998 (AgSTAR 1998: 1):

Over the past 18 months, six AgSTAR Partners have installed biogas recovery systems and established new profit and environmental centers. This increase in demand is the largest experienced since the mid-seventies. At least 10 more biogas projects are in either planning or construction phases.

If this is compared to the Lusk report (1998), written the same year, we can see how critical AgSTAR was for the development of digesters during this period. Even after decades of research and development with the assistance of the state, by 1998, the number of operating projects was still very low- roughly 28 in the entire US. By the spring of 2000, the number had increased only slightly to 31 projects, but at this point, AgSTAR had successfully established 13 different projects across the country just as the charter farm program ended in the fall of 1999 (AgSTAR

2000). In other words, by 2000, almost half of the operational digesters in the US (42 percent) were AgSTAR Charter Farms.

It is interesting to note that Moser, who I discussed in the context of digesters in the late 1970s and early 1980s, is now head of his own digester engineering firm, RCM Digesters (AgSTAR 2003). Considering he was part of the team creating one of the first digester prototypes, it is not surprising that Moser became a subcontractor writing reports and designing projects under AgSTAR from the 1990s on. Moser was very active in a number of projects on AgSTAR Charter Farms. He also was one of the authors of the second edition of the AgSTAR Handbook (2004). Once again, we can see the importance of these networks that formed in the early years of digester development and deepen the nexus: a student of a professor within a land-grant university who then moves to the private sector only to move back into this blurred public/private sector where he continued to work on and write about these projects for development in the private sector.

Section 5.4: Locking-in to Biogas in Wisconsin's Dairyland

From the mid-2000s onward, a boom for the biogas industry emerged once again across the US. By 1999, AgSTAR had already improved all of the existing digester prototypes and implemented them on 13 different farms. Then in 2002, federal funding for digesters specifically for agricultural operations increased dramatically as a part of the 2002 Farm Bill (AgSTAR 2004). The 2002 Farm Bill was the first to include a section purely devoted to energy. According to the Congressional Research Service (2019: 3), “Since enactment of the 2002 farm bill, interest in renewable energy has grown rapidly.” This bill included \$801 million (\$1.3 billion today) for

mandatory funding and \$294 million (\$491 million today) in discretionary funding. All of the discretionary funding went towards biomass research and development. Most (75 percent) of the mandatory funding went towards the continuation of the Bioenergy Program, a program that used federal funds to paid biofuel producers to expand production and 15 percent went to the Renewable Energy Systems and Energy Efficiency Improvements program, which eventually became the Rural Energy for America program (REAP), a key source of funding for digesters to this day (Congressional Research Service 2019).

Funding was also distributed to the Environmental Quality Incentives Program (EQIP), “a voluntary program that provides farmers with financial and technical assistance to plan and implement soil and water conservation practices,” (Congressional Research Service 2011: 2). EQIP was renewed in the 2002 Farm Bill and received significantly more funding than in the past— from \$300 million which would incrementally increase to \$1.4 billion by 2007. The Farm Bill designated 60 percent of the funds in this program towards animal operations due to the rising pressure the industry was facing to confront their CAFO problem (AgSTAR 2004). This program offered to fund up to 70 percent of costs associated with the purchase and installation of digesters. The 2002 Farm Bill also increased funding for the Rural Business Cooperative Service within the USDA in order for them to distribute \$23 million in grants specifically for covering up to 25 percent of start-up costs (AgSTAR 2004).

According to Larry Krom, the bioenergy project manager for Focus on Energy (Goldstein 2009), “Until a few years ago, people told us they were interested in farm digesters as a means of nutrient management...Over the last couple of years, having another revenue stream from energy production started to gain equal footing with nutrient management.” Wisconsin, at this point in 2002, had only two digesters in the entire state. But the timing here is also crucial. To take a step

back in the regulatory history of Wisconsin, I need to bring in *Focus on Energy*. According to AgSTAR (2009: 66):

Focus on Energy, a public-private partnership providing information and services to energy consumers in Wisconsin, aims to promote energy efficiency and renewable energy, improve the environment, and ensure the future supply of energy in the state. Services are delivered by a group of firms contracted by the Wisconsin Department of Administration's Division of Energy.

Throughout the 1990s, Wisconsin began to increasingly deregulate the Wisconsin Public Service Commission (WPSC), a regulatory agency that was responsible for overseeing a number of public utilities such as electricity and natural gas (Johnson 2013). The WPSC monitored the provision of various “public benefits” for customers of utility companies such as 1) programs devoted meeting the energy needs of low-income households, 2) the development of incentives for adopting renewable energy projects and more energy efficient technologies, and 3) studies aimed at managing the environmental harms caused by energy production and use. In 1995, the same year Conservative Governor Tommy Thompson was re-elected with a Republican majority for the first time since the 1960s, the WPSC began initiating a “transitional process” requiring that these programs were taken over by third-parties as time went on; a great example of a PPP. By that point the WPSC became concerned that if these activities were completely taken over by the private sector (Johnson 2013: 3):

...it was reasonable to expect that most would not provide, on their own initiative, the same types of public benefits [demand-side management programs] that the traditional regulated utilities were required to provide... Thus, for policymakers, an emerging issue in the deregulation debate became the question of who would provide and fund these public benefits, if they were no longer provided by the utilities.

In other words, the private sector did not want to spend their money on programs for the public when they could be spending it on activities that increase profit maximization. In 1998, a large

utility company in Wisconsin, We Energies, approached WPSC and offered to partially fund and operate an energy efficiency pilot program called “Wisconsin Focus on Energy.” It was adopted by the legislature after the pilot project was completed in 2001.

Between 2003-2006, the number of digesters on farms in Wisconsin increased from 6 to 21, an increase of 250 percent in three years (AgSTAR 2003; AgSTAR 2006). By 2006, Wisconsin had the highest number of dairy digesters in the US, surpassing even the state of California (see figure 5.3 below). From this point on, Wisconsin has had the highest number of dairy digesters in the US (AgSTAR 2010; Wisconsin Office of Energy Innovation 2016). Why did Wisconsin have so many more digesters than any state in the US? In the same edition of the AgSTAR (2006) digest that included figure 5.2, there was also an entire section devoted to sharing the success stories of the Focus on Energy program in Wisconsin. Focus on Energy provided a new market for electric energy in Wisconsin and this encouraged the adoption of digesters during a period where prices for energy were high. By 2006, the Focus on Energy program was established and ready to expand. According to AgSTAR (2006: 3):

Among these programs, the [Public Service Commission of Wisconsin] approved a new "Biogas Buy-Back Rate," which pays 8.0¢/kWh for "on-peak" energy and 4.9¢/kWh for "off-peak" energy to customers who generate electricity from anaerobic digester technology using waste from animal feeding operations, industrial food processing, or municipal wastewater treatment facilities.

With these programs, utility companies would pay CAFO owners premium prices for the electricity they generated with on-farm digesters. In recent interviews with CAFO owners who participated in the program, they indicated that the market for electricity that was stimulated by Focus on Energy was central to their decision to adopt digesters. Crave Brothers Farm, for example, had a digester installed in 2006 in order to sell electricity directly to We Energies (Markham, Blaha, and Michalesko 2022). In this agreement, called a Power Purchase

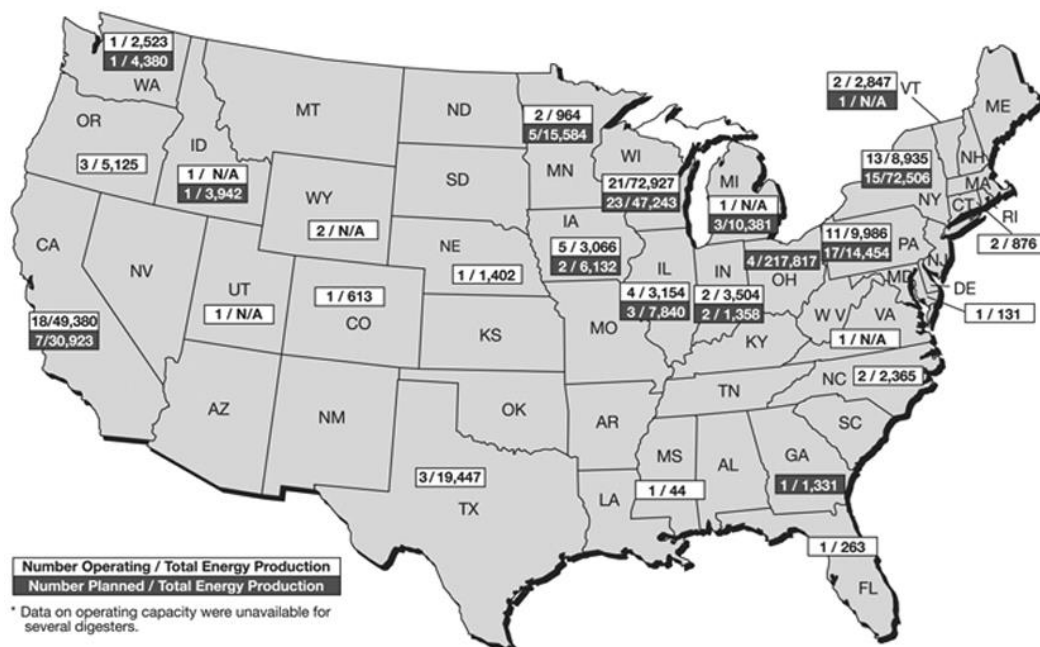


Figure 5.2: Number of Operating and Planned Digesters on Farms in the US in 2006 (AgSTAR 2006).

Agreement, We Energies agreed to purchase the electricity their on-farm digester created between 2006 all the way up to 2022. The table below (table 5.1) was created by Joe Kramer for the Focus on Energy program in 2009 and includes more examples of utility companies and CAFOs involved in the program at the time. By that point in 2009, the program included 21 different projects.

At the time I was interviewing regulators in Wisconsin, I had no knowledge of the specifics of the history of the “roll-out” of digesters in that state, including Focus on Energy. Although Regulator 2 (2022) did not explicitly remember what these programs were called, or remember if they were exclusive to the state, they realized that they needed to make sure I was at least aware of them. This history lesson began in the middle of a discussion about the types of digesters and their differences:

Regulator 2: Not as efficient as the complete mix digester, but they're also cheaper. There were quite a few of those built. It's on a- Do you know the history of digesters very much?

D'Onofrio: No. But I'm about to learn! *laughs*

Regulator 2: So back around 2010- early 2000's maybe- there were, there were incentives for electrical utilities to generate electricity with renewable energy. And so, because of that incent- And then they would pay- If you're going to have a manure digester and they would run a generator to generate electricity, they would have contracts with local electrical utility that gave them a pretty high rate for their electrical generation. And so they had these contracts to generate all this electricity at a, at a pretty, at a profitable rate because there are these incentives. I think there might have been some kind of regulatory requirement for electrical utilities to have some percentage in renewables.

D'Onofrio: Was that in Wisconsin or a national thing?

Regulator 2: I'm not sure. It might have been national, but I know- Or maybe... I'm not positive. But anyway, there was this generation of digesters built like 10, 15 or so, years ago, to generate electricity. And the generators were like, big diesel motors.

I did not realize it at the time, but I had just been given a description of the Focus on Energy program. According to Regulator 2:

Regulator 2: And so after a while- these contracts were usually like five years or so- and then I think the regulatory requirement went away or there were generally utilities were

Table 5.1: WI CAFOs with utility contracts in 2009 (Kramer 2009).

Farm name	Business Model	Utility	Utility Contract Type
Baldwin Dairy	farm owns digester, looking at biogas use options, may supply heat to other farm operations	St Croix Electric Coop	na
Central Sands Dairy	farm owns all	Dairyland Power	na
Clover Hill Dairy	farm owns all, sells electricity to utility	We Energies	sell-all
Crave Brothers Farm	Clear Horizons owns digester and energy generation, farmer buys solids and fertilizer back from CH, We Energies buys electricity.	We Energies	buy excess
Deere Ridge Dairy	farm owns digester and sells biogas to utility, utility owns and operates generator on site	Alliant Energy	sell-all biogas
Double S Dairy	farm owns all, sells electricity to utility	Alliant Energy	sell-all
Emerald Dairy	farm owns digester, energy generation, energy used on farm	St Croix Electric Coop	na
Five Star Dairy	Microgy built, operates and maintains digester, Dairyland buys biogas and owns/operates genset and scrubber, sells elec to member coops, gas sales and carbon credits buy down debt for farmer on digester	Dairyland Power	biogas sales to Dairyland Power, output goes into Dairyland system and is made available to member coops
Green Valley Dairy	farm owns all, sells electricity to utility	We Energies	sell-all
Holsum Dairy (Elm Road)	farm owns all, sells electricity to utility	Wisconsin Public Service	sell-all
Holsum Dairy (Irish Road)	farm owns all, sells electricity to utility	Wisconsin Public Service	sell-all
Lake Breeze Dairy	farm owns all, sells electricity to utility	We Energies	sell-all
Norm-E-Lane	farm owns all	Dairyland Power	sell-all
Norswiss Farms	Microgy built, operates and maintains digester, Dairyland buys biogas and owns/operates genset and scrubber, sells elec to member coops, gas sales and carbon credits buy down debt for farmer on digester	Dairyland Power, Barron Electric	biogas sales to Dairyland Power, output goes into Dairyland system and is made available to member coops
Pagel's Ponderosa Dairy	farm owns all	Wisconsin Public Service	sell-all
Quantum Dairy	farm owns all, sells electricity to utility	We Energies	sell-all
Sunrise Dairy	farm has new owners, digester and genset owned and operated by third party	Wisconsin Public Service	sell-all
Vir-Clar Farm	farm owns all, sells electricity to utility	Alliant Energy	sell-all
Volm Farms	farm owns all	We Energies	sell-all
Wild Rose Dairy	Microgy built, operates and maintains digester, Dairyland buys biogas and owns/operates genset and scrubber, sells elec to member coops, gas sales and carbon credits buy down debt for farmer on digester	Dairyland Power	biogas sales to Dairyland Power, output goes into Dairyland system and is made available to member coops

getting different renewable energy sources, like wind and solar. So a lot of these contracts were not renewed, so the- Some of the farms who had these systems, they didn't continue operating because it was no longer profitable for 'em.

D'Onofrio: Oh okay.

Regulator 2: Yeah. And when you're generating electricity, with methane, the methane doesn't have to be very clean.

D'Onofrio: Mhmm.

Regulator 2: And so, you can get by with these simpler design digesters, these plug flow digesters. So quite a few of these plug flow digesters were built. And I think most of them are still being used but I have heard of some, they just stopped using them.

Here, regulator 2 was touching on a recent, but very important development in the saga of digesters. Just like in the case of Crave Brothers Farm, within the last few years, many of the power purchase agreements between CAFOs and utility companies have expired and are not expected to be renewed due to the use of other types of renewable technologies. Without these favorable contracts, the market for biogas in Wisconsin over the last several years has weakened immensely.

For example, when Dallman East River Dairy hired a digester developer, DVO Inc., to install a digester in 2012, the utilities paid between 15-16¢/ kWh for their electricity (Markham, Blaha, and Michalesko 2022). However, in the late 2010s, the price utilities were offering for electricity had dropped dramatically and, “When it went down to two to three cents per kWh, there was no way,” (7). In 2019, Dallman East River Dairy, like many other CAFO owners in Wisconsin, hired a new digester developer, U.S. Gain, in order to tap into a new, more profitable market for RNG, which the dairy industry has begun to recently refer to as “brown gold.”

Section 5.5: CAFOs and Environmental Inequality in Wisconsin

Kewaunee County, Wisconsin is a small, rural county of around 20,500 people in Northeastern Wisconsin, 70 percent of which rely on well water as their only source of water

(US Census 2022; Kewaunee County 2023). Like many rural Midwestern counties, the population of Kewaunee County is almost entirely white (96 percent) with a median income of \$72,328. Although the demographics of Kewaunee County show that it does not fall into the category of a traditional “EJ” community, which typically includes minority and low-income residents, locals still experience environmental inequality through their daily experiences of living near unregulated dairy CAFOs. Kewaunee County is the most CAFO dense county in Wisconsin where cows outnumber people 5 to 1 (Dukehart 2017). Indeed, there are 15 CAFOs in this county alone with each one housing over 700 cows which produces as much waste as 1.6 million people (Hribar 2010; Bergquist 2015). Over the last 20 years, residents of Kewaunee County have struggled to protect their water sources from contamination from agricultural runoff and after all that time it seems to be getting worse.

What is particularly puzzling about why there are so many CAFOs in Kewaunee County is that it is located on top of karst topography, a landscape formed from the dissolution of soluble rocks such as limestone, dolomite, and gypsum which exacerbates the potential for groundwater pollution (Wisconsin Geological and Natural History Survey 2022). The soil and ground of the area is so loose that it is prone to sinkholes that can range from a few feet across to the size of tractors. As I highlighted in chapter 3, the use of an NMP does not mean that CAFOs are following them as they should. And regardless of the use of NMPs, a significant amount of pollution still makes its way into the air and water of rural communities that live around them. These local soil conditions, combined with the amount of manure CAFOs spread on fields makes pollution of groundwater more likely even when farmers use “best management practices” for manure management (Golden 2014). Unsurprisingly, drinking water contamination is a common problem in northeastern Wisconsin as shown in figure 5.3 below.



Figure 5.3: Tainted well water from Kewaunee County, Wisconsin (Whites-Koditschek and Dukehart 2019).

Over the last 20 years, residents of Kewaunee County have struggled to protect their water sources from contamination from agricultural runoff and after all that time it seems to be getting worse. In 2004, Kewaunee County had their first high profile public health scare related to CAFO pollution in rural communities. In early March 2004, all five healthy members of the Trembl family became simultaneously ill with severe salmonella poisoning after drinking contaminated water from their well (Midwest Environmental Advocates 2022). The Trembl family lived across the street from Stahl Farms, a CAFO with 900 dairy cows. Stahl Farms, as it turns out, had just illegally spread thousands of pounds of manure on a local field which then seeped into School Creek and the surrounding groundwater that the Trembls used for drinking. This incident outraged the community because not only did they consider these to be reckless farming practices on the part of the CAFO, but also because their seven month baby had to be hospitalized. It was not until after the case of the Trembl family that the locals started realizing the effects on their well water were much more widespread than previously suspected. Before the experts were enlisted or individuals started testing their well water for chemicals, locals could tell the water was not what it used to be. In some cases, the water had a strong, repulsive smell. In others, the water was yellow or a deep brown (Whites-Koditschek and Dukehart 2019).

In 2014, after years of having their concerns ignored by the WDNR, the residents of Kewaunee county finally received some recognition from the state of Wisconsin that the WDNR needed to step up and do their jobs when an administrative law judge called the regulatory efforts of the WDNR a “massive regulatory failure” (Seely 2014). The failure of the WDNR to enforce regulations and groundwater pollution that emerged as a result was so egregious that locals submitted a formal request to the US Environmental Protection Agency (EPA) to investigate if the WDNR was actually checking that these facilities are in compliance with environmental

regulations (Groundwater Collaboration Workgroup 2016). In response to this request, in 2015, the EPA and WDNR organized a series of “stakeholder” meetings that they referred to as the Groundwater Collaboration Workgroup. The meetings included both of these regulators, CAFO owners, legal advocates for rural communities, residents of Kewaunee county including Lynn Utesch of Kewaunee CARES, a group of residents and local farmers that oppose the environmental practices of CAFOs.

By 2015, the WDNR had funded and completed a study of well water in the area. They found that 34 percent of wells tested positive for unsafe levels of nitrates and bacteria (Bergquist 2015). As highlighted by the Wisconsin Department of Health Services (2019), when nitrate levels in drinking water are higher than 10 ppm, it can impact everyone, even healthy adults. Exposure to nitrates can cause spontaneous miscarriages or birth defects, thyroid problems, gastrointestinal problems, and also various cancers (Lin et al. 2023; Huang 2018). In a recent study in New Zealand, another site of dairy production, epidemiological research found that high levels of nitrates were associated with the development of colorectal cancer (Richards et al. 2022). Studies have also connected the daily consumption of nitrates to thyroid conditions such as hyperthyroidism, particularly in women (Aschebrook-Kilfoy et al. 2012).

The studies continued as rates of contamination and environmental illness rose in the county. In 2017, researchers found that 60 percent of wells in the county were contaminated with nitrates and dangerous pathogens including cryptosporidium, which, as I discussed in chapter 3, caused a massive outbreak of waterborne illness in 1993 (Dukehart 2017). The water also contained Rotavirus C, a gastrointestinal virus that can jump from cows to humans. According to Mark Borchardt, the scientist leading the water tests in Kewaunee County, “Rotavirus C is more

widely understood to be found in India and China, but new studies are showing that it's starting to appear in the U.S...We've never seen these results in groundwater before,” (Dukehart 2017).

From the beginning of Kewaunee County’s issues with pollution, CAFO owners and representatives of the dairy industry such as the Dairy Business Association, used uncertainty to deflect the blame. They insisted that scientists could not determine whether the waste came from cattle or from leaky septic systems used by people (Bergquist 2015; Dukehart 2017). And this was true in some respects. Although sampling suggested that manure was a central issue, due to the nature of runoff, it is difficult to purely assign blame to animals. In the 2017 sample, “...40 of the 79 tainted wells contained bovine microbes; 29 contained human microbes, and seven had both. The remainder of the contaminated wells had microbes that could have come from either source,” (Dukehart 2017). However, in 2021, over a decade after the first high-profile pollution case in Kewaunee County, an in depth federal study aimed at resolving this uncertainty was finally completed. USDA researchers found that only twelve of the 301 cases of gastrointestinal illness from contaminated drinking water was caused by human waste (Burch et al. 2021). The vast majority of cases, 230 of 301, could be attributed directly to cow manure.

Public health researchers have recently noted that air pollution from CAFOs in Wisconsin was associated with a number of negative health outcomes for the people living nearby (Schultz et al. 2019). In a survey of 5338 adults who resided near CAFOs in Wisconsin, the researchers found that, compared to those who lived 5 miles from a CAFO, residents within 1.5 miles experienced higher rates of asthma, use of asthma medication, uncontrolled asthma, asthma attacks, nasal allergies, and lung allergies. However, it is absolutely key to point out, which many public health researchers *do* in their analyses of environmental health problems associated with CAFOs, that these health issues remain immensely understudied. Since the NAEMS was

never completed, there are no comprehensive studies on the health impacts of air pollution from CAFOs across the US.

Section 5.6: The Promises and Pitfalls of Digesters as a Climate Change Solution

In the debates leading up to the biofuels boom in the early 2000s, ethanol was framed by proponents as a “no brainer” (Lehrer 2009). There were so many benefits to ethanol production that there seemingly was no downside, at least until researchers knew more about the economic, social, and environmental impacts years later (Leopold 2014). The fact that ethanol, a relatively obscure source of biofuel, suddenly entered the spotlight as it was aggressively advocated by industry actors, suggests that discourse and power play an important role in determining viable solutions. At this moment, it seems as if we are reliving the biofuel debates, but in the realm of biogas. Once again, actors within the agricultural state/science/industry nexus have made digesters seem like a “win-win” for the dairy industry. Here, we can see the “common frame” emerge once again in how proponents of digesters within the state/science/industry nexus, such as the USDA, EPA, the DoE, agricultural science departments and academics in land grant universities, agricultural lobbying and trade groups, and agribusinesses, use overwhelmingly positive language to discuss digesters while obfuscating their shortcomings for small farmers and rural communities and provide a much needed boost of legitimacy during the age of climate change.

In this section, I challenge the central claims proponents of digesters are using to frame them as a “win-win” for the environment, farmers, and rural communities. To begin, here is a quote from the USDA (2017, emphasis added) that highlights the “conventional wisdom” (Lazenby 2022) used to support digesters:

Anaerobic digesters actually provide two-fold greenhouse gas reduction. First, they **capture methane** that otherwise would be emitted from the manure into the atmosphere. Second, by **utilizing the trapped biogas as a renewable energy source**, digesters displace the need for additional fossil fuels. In addition, digesters **eliminate odor, reduce air pollution, kill disease-causing bacteria, and improve water quality**.

The most recent green benefit of digesters, according to proponents, is the ability to turn manure into a source of “clean fuel,” which the industry is once again referring to as “brown gold” (Howard 2018; Cohen 2022). According to the AFBF, the most powerful agricultural lobbying organization in the US (Newton 2019, emphasis added):

Methane digesters have turned waste into a value-added product used on and off the farm. In the last five years, the use of methane digester technology has increased by nearly 30%, helping to turn waste into **clean natural gas**, fertilizers and other renewable products. Using digester technology and feed additives designed to reduce enteric fermentation, milk production in the U.S. could ultimately achieve net zero emissions.

This framing of ethanol as clean and green was also central within the biofuels debate between 2006-2008.

Another not-so-new framing of biogas comes directly from the biofuel debates. In this familiar perspective, the products of digesters are once again framed as a way to achieve “energy independence.” According to AgSTAR (2022a):

Many early farms and other agricultural operations, such as mills, were often energy independent, getting their power from wind or water sources. Manure provides an opportunity for farm energy independence.⁶

⁶ Food for thought: If we are to go back to the very beginning of this chapter to the scenario discussed by Marx regarding the value created for capitalists by nature using the example of a capitalist that owns a waterfall, we can see very different understandings of ‘nature.’ At least for Marx, nature produced the “labor” that created value for the capitalist in the form of energy that came from moving water. In this quote, however, there is no recognition at all of this nature/labor. Despite the fact that the farmer in this case is relying on nature’s “labor” to supply their energy needs, nature is framed as a given, something that can be taken for granted as a key dimension of this “independence.”

Similarly, Dairy Farmers of America (2022) state that, “Anaerobic digestion can change the economics and carbon footprint of a farm, allowing generational sustainability and energy independence.” Almost two decades after the biofuel debates, there seems to be significantly less emphasis on the Middle East. Independence in this case seems to refer to the farm’s independence in general. But this discursive choice is not random. As noted by Vogeler (1981: 6):

Farmers appear to be, and even believe themselves to be, independent, but in reality they are in the power of forces beyond their control. In the United States the myth of the family farm continues to be used for the benefit of a relatively small group of large-scale producers and agribusiness firms, while the vast majority of rural and urban people, believing the myth, pay the economic, political, social, and environmental costs of this fantasy.

Here it is important to note that framing farmers as “independent” has been a key strategy used by large agribusiness corporations to obfuscate the ways that reality of farming has become dominated by corporations that use contracts to control the farmers that produce their commodities over the past several decades (Hamilton 1994; MacDonald and Key 2012; Constance et al. 2013).

Indeed, one of the most useful discursive strategies used by actors within the agricultural nexus, is to appeal to the nostalgic tradition of small family farmers despite the fact that most agricultural production (and the corresponding profits) go to the largest farms. It should not be surprising, then, that these digesters also disproportionately benefit the largest CAFOs.

According to the AgSTAR project development handbook (2020: 13):

Successful farm-based AD/biogas systems typically operate with at least 500 cows in dairy operations or at least 2,000 hogs in swine operations.¹ As economies of scale yield more favorable conditions (e.g., larger number of animals, larger amount of recovered manure, increased amount of salable products produced) the likelihood of successful application and profitability increases. For example, dairy farms having greater than

1,000 animals or hog farms having greater than 5,000 animals increases the likelihood of project success.

Some digester projects are installed on small farms, but this is not typically the case because they require an immense amount of capital to pay for high start-up costs (AgSTAR 2020; Cowley and Brorson 2018; Smith 2023).

Dairy Farmers of America, the largest dairy co-operative in the US, also appeal to “clean” and “green” discourses in their description of digesters (Dairy Farmers of America 2022):

Think of a giant garbage disposal. Now think of a garbage disposal on steroids. That’s an anaerobic digester. It takes cow manure from dairy farms and even food scraps from local restaurants and businesses and turns it into clean energy. That clean energy goes on to fuel the dairy and the towns and cities nearby. It all comes full circle when the liquids produced from the digester are used to fertilize dairy farm crops and the solids are used for cows’ bedding.

In the last sentence of this quote, Dairy Farmers of America go beyond a focus on energy (pardon the pun) and draw from discourses around manure management that have been around for decades. For example, Kinnard Farms, one of the largest dairy CAFOs in Wisconsin, frames manure management like this:

We like to think of our farms as a big recycling plant. The cows eat and produce manure, and we apply that manure to the soil in measured amounts. The roots of the crops absorb the nutrients, removing the manure from the soil. We harvest the crops in the fall to feed our cows, our cows produce wholesome, high-quality milk, and the cycle continues (Kinnard Farms n.d.).

These discourses, which frame industrial agricultural practices as traditional, pastoral forms of agriculture, disguise the reality of the metabolic rift that CAFOs produce as I described in chapter 1. According to state actors such as the EPA, USDA, and the Natural Resource Conservation Service (NRCS)—an agency within the USDA that provides educational support

for mostly voluntary soil conservation measures, but also NMPs– manure spreading on CAFOs is not only legally acceptable, but a safe form of waste disposal. As I discussed in chapter 3, the entire point of NMPs in the realm of manure management on CAFOs is to enable the continuation of manure because of its value as a fertilizer (EPA 2003). To use a quote from an educational resource created by a very literal example of the nexus, which included the EPA, the National Pork Producers Council, National Cattlemen’s Beef Association, U.S. Poultry & Egg Association, United Egg Producers, National Milk Producers Federation (2015):

Throughout history, people who raise livestock and poultry have used manure as a fertilizer, soil amendment, energy source, and even construction material. Manure contains many useful, recyclable components, including nutrients, organic matter, solids, energy, and fiber. With today’s science and technology, we can use manure more efficiently and in more ways than ever.

But despite insistence within the state/science/industry nexus that manure is perfectly safe to use in large quantities near peoples’ homes and sources of drinking water, the conversation around digesters shows that framing CAFO waste as a valuable input for farms is not as politically viable as it used to be.

Indeed, in the last five years, discourse around manure has begun to shift in revealing ways, as highlighted by Land O’ Lakes in their 2021 ESG (environmental and social governance) report (21):

Cow manure was once considered nothing more than waste. Now, it can be considered an important resource and piece of the sustainability puzzle on farms – thanks to a first-of-its-kind collaboration formed in 2018 between Land O’Lakes and California Bioenergy (CalBio), a leading dairy digester developer. Together we’re helping our California dairy member-owners use anaerobic methane digesters to generate renewable energy from farm waste, or “barn-to-biogas.”

This quote represents a shift from dominant discourses around manure management for the past thirty (or more) years which framed CAFO manure as a natural, viable way to fertilize crops. But

it obscures the fact that digesters *do* produce waste. Digesters do not make millions of pounds of manure and the emissions it produces magically disappear. Rather, they transform these elements into something else. These new waste products have their own unintended consequences.

The first inconsistency I noted between the scientific literature and resources used by the state had to do with digestate. According to Li et al. (2018: pn):

Digestate is a fully fermented nutrient-rich material, especially containing a high proportion of ammonium, which is available for plants. Moreover, it contains other macro- and micro-elements necessary for plant growth. Traditionally, digestate can be used as a fertilizer due to its nutrient content (Chen et al., 2014).

Digestate is framed as a safer alternative to spreading untreated manure on fields because proponents claim that digesters reduce the quantity, odor, and pathogen content of manure which results in improved water and air quality (Li et al. 2018; Van Dyne and Weber 1994; Harrison and Ndegwa 2019). For each of these claims about digestate, I found contradictory information within the scientific literature. First, proponents of digesters have made claims that they can lessen the manure burden on farms because they *reduce* the volume of manure (Wisconsin Public Service 2022; Wukovitz and Schnitzhofer 2009). Other sources claim that this is not the case (Wisconsin Bioenergy Initiative 2011; Camillo 2013). Penn State Extension (2012) found that, “Anaerobic digestion does not reduce the volume or nutrient value of manure. If dilution water is added to the system, the volume of material to handle is increased.” A common practice with digesters is to add co-digestates such as food waste (Harrison and Ndegwa 2019). In other words, if water or food waste is added to the digester, these technologies increase the already massive amount of manure on farms and contribute more to the issue of waste management.

Proponents also claim that digesters dramatically reduce the amount of harmful pathogens in manure such as bacteria, viruses, and parasites (Glibert 2020). There have been

many studies demonstrating that digesters do in fact decrease these substances (Lusk 1998; Harrison and Ndegwa 2019). According to AgSTAR (2018), “Digesters, particularly heated digesters, can destroy more than 90 percent of disease-causing bacteria that might otherwise enter surface waters and pose a risk to human and animal health,” (5). Other studies note that number can be even higher- up to 99.9 percent of pathogens can be eliminated from manure (Lusk 1998; Manyi-Loh and Lues 2022). However, studies also show that digesters do not eliminate them and what we know about the variation between how digestate is produced at different farms is very limited (Burkholder et al. 1997; Mallin 2000; Burch et al. 2018; Harrison and Ndegwa 2019).

As I have shown throughout this chapter, most of the research on digesters was driven by studies that aimed to promote their capacity to generate energy or eliminate methane. Although the social and environmental benefits of these technologies have been part of the conversation for over 60 years, the existing literature supporting these conclusions are weak. Conclusions about pathogen reduction have been drawn from studies that were conducted in laboratories, which are highly controlled environments (Burch et al. 2018). Only a small number of studies have been conducted on the pathogen content of digestate on CAFOs *in the real world* (Kearney et al. 1993; Gantzer et al. 2001; Massé et al. 2011 as cited in Burch et al. 2018). And of those studies, all of them use observations of only one or two digesters. In the study conducted by Burch et al. (2018), they addressed these limitations by testing the pathogen levels of digestate from 9 different facilities in southern and eastern Wisconsin over a period of 9 months. They found that after the digestion process, the microbial content of the digestate was lower, but levels of “inactivation” of those microbes varied substantially across different digesters during different seasons. According to Burch et al. (2018: 342):

First, the high degree of variability in microbe inactivation across both digester and season is itself indicative of poor digester performance. Second, the volatile solids destruction achieved by these digesters that was measured in the related study provides corroborating evidence for their generally poor performance.

As I noted at the beginning of this dissertation, the process of digestion separates manure into a solid and liquid form. After the completion of the digestion process, the researchers found that “nearly every microbe we could detect” could be identified in the liquid digestate, which is framed as a safe to use fertilizer on fields around people’s homes (342). This highlights another important “unsaid” detail in the discussion around digesters: the microbial and pathogenic content of manure is so high that even if substantial inactivation takes place, there are still enough left over to reproduce over time and contribute to negative human health outcomes (Borchardt et al. 2012).

Although digestate is “safer” in many ways compared to raw manure, there are also new negative impacts that could worsen if these technologies are adopted on a large scale, particularly in the case of ammonia and nitrous oxide (N_2O). For example, during the digestion process, researchers have identified that ammonium is often transformed into ammonia (Harrison and Ndegwa 2019). Since ammonia has a higher potential for volatilization (to turn into a gas) than nitrogen, this has the potential to dramatically increase the creation of fine particulate matter which is already the leading cause of air pollution deaths from agricultural production (Domingo et. al. 2021). In other words, digesters have found a way to reduce methane, a potent greenhouse gas, but at the same time, they have begun producing higher levels of ammonia which has worse implications for human health as I discussed in chapter 1 (Donham et al. 2007; Domingo et. al. 2021). In fact, Holly et al. (2017) found in their study of digestate from a commercial farm and a USDA farm in Wisconsin, that in storage, ammonia emissions increased 81 percent. Again,

digesters do not destroy what goes into them, but transforms it. Here, proponents can frame digesters as beneficial for people because they destroy potent GHGs, but other byproducts that are actually more harmful for human health, are ignored.

Another understudied dimension of digesters is their propensity to emit nitrous oxide (N_2O), another GHG that contributes to climate change. According to the EPA (2023), “The impact of 1 pound of N_2O on warming the atmosphere is almost 300 times that of 1 pound of carbon dioxide.” On top of this immense warming capability, nitrous oxide stays in the atmosphere for 114 years, which is significantly longer than methane. Since 1990, nitrous oxide emissions have risen 40 percent in the agricultural sector. Almost half (48 percent) of all GHG emissions within agriculture are from nitrous oxide and agriculture is already the largest source of this hyper-potent GHG in the US. In addition to finding that in storage, the ammonia content of digestate increases dramatically, Holly et al. (2017) also found that it also increased nitrous oxide emissions by 81 percent, resulting in an overall emission “tradeoff.”

Last, but certainly not least, I address a claim that has been central to the “story” of digesters: their ability to reduce odors. Besides the generation of “clean energy,” the odor reduction of animal waste is one of the top reasons for CAFOs to adopt digester technologies. As CAFOs have become larger since the 1970s, digesters are a tool that is consistently advocated by those within the nexus to keep the peace with neighbors and avoid the looming threat of lawsuits, at least until RTF law restricted that for many people. Still, the EPA, USDA, and AgSTAR frame odor reduction as a key benefit of digester adoption for farms in the US (AgSTAR 2020). Indeed, according to the USDA, digesters have “the sweet smell of success,” (Adame 2011). However, the absence of smell does not mean that the gasses that were present before are gone, but rather, they were transformed into other gasses with smells less offensive to people (Lazenby 2022).

Besides ammonia, digestate releases a number of gasses known as volatile organic compounds (VOCs). An issue with the existing research on digesters is a hyper focus of study on the compounds that cause the odors. When Zheng et al. (2019) studied the VOCs released from digestate during storage, they detected 49 different types of VOCs. The VOCs that caused odors represented only a small fraction of the VOCs present (5.15 percent of total VOCs), but non-odorous compounds that were hazardous to human health were still present. In fact, almost a third (32.77 percent) of the total VOCs emitted from digestate were hazardous to human health. Indeed, 8 of the compounds they discovered were carcinogenic and 14 were known to cause organ damage in humans. Overall, Zheng et al. (2019) noted that based on these findings, the research on the impact of digesters on human health “deserve[s] more attention,” (9).

Section 5.7: Conclusion

In theory, digesters enable capitalists to reach the sweet spot of green capitalism which purports to decouple the contradictory relationship between economic growth and environmental degradation (Wanner 2015). As I have shown throughout this chapter, for the last 60 years proponents within the agricultural state/science/industry nexus have claimed that these technologies offer immense environmental benefits. Indeed, actors involved in this newly developed biogas/biomethane market have collectively renamed manure “brown gold.” Land O’ Lakes, one of the largest dairy co-operatives in the US, has gone so far as to claim that manure “is not a waste anymore” (Fu 2023; Land O’ Lakes 2022: 21)

Although these machines may reduce methane, they increase carbon dioxide and nitrous oxide emissions which are substantially higher than both methane and carbon dioxide (Holly et al. 2017). And when the overall emissions reductions are taken into account, the amount of

methane reduced does not even put a dent in the overall methane emissions from the livestock industry. According to AgSTAR, in 2020 methane digesters on farms resulted in the destruction of 5.26 million metric tons of carbon dioxide equivalent such as methane (AgSTAR 2022c). However, in 2021, the methane emissions from enteric fermentation and manure management in the US was over 265 million metric tons of carbon dioxide equivalent (EPA 2023). This means that methane digesters in 2021 *only reduced 2.3 percent of methane* from just these two sources of methane from animal agriculture in the US.

While their purported, (yet miniscule) climate benefits are praised, digesters produce more environmental health problems for neighbors. They produce more ammonia, which as I show in the next chapter, CAFOs are already struggling to contain. But from the very beginning, digesters were framed as a way to reduce conflict with neighbors based on pollution that is inherent to CAFO production. This is one dimension of the narrative around digesters that has not gone away all of these years. In taking a closer look at these claims, I realized that many uncertainties, gaps, and contradictions still remained. Digesters are not magic machines that make waste disappear or turn waste into a harmless substance. Ultimately, it is still animal waste that comes out of these machines, just in a more concentrated form (Lazenby 2022; Harrison and Ndegwa 2019). Despite all of the time digesters have been operational on CAFOs there are a surprisingly small number of studies that look into the public health impacts of the digestate and the fumes that digesters produce.

To go back to chapter 1, I introduced the idea of a false solution. One of the central components of a false solution is its imposition of the costs and risks, many of which are not fully understood, on actors with less political power. Throughout this dissertation, I have shown that the livestock industry over the last 100 years has gained immense political influence. Indeed,

the AFBF remains one of the most powerful actors in politics today. Digesters are valued by the dairy industry despite all of their flaws because they enable them to continue on with production just like it was business as usual. This goes back to a quote that caught my attention in the Lusk Report (1998: 12):

Moreover, without the environmental benefits provided by AD technology, some might have been forced out of livestock production. AD is sometimes the only technology that allows growth in the livestock production business.

CAFOs have used digesters, RTF law, and now greenwashing to delay the inevitable. But in the era of climate change it is starting to catch up with them.

Chapter 6: California's Neoliberal Climate Change Mitigation Programs: Turning Methane From a Climate Problem to a "Market Solution"

Section 6.1: Introduction

In the last chapter, I introduced the chorus of voices within the nexus that have sung songs of praise for digesters as a solution to the social and environmental problems caused by CAFOs over the last 40 years. I also challenged these claims by highlighting the many negative qualities of digesters that are too often completely ignored by actors within the agricultural nexus. In this chapter, I take a step outside the nexus and into the markets themselves. With programs such as "Focus on Energy" in Wisconsin in 2000, the federal RFS program in 2005, and, the focus of this chapter, California's marketized climate change mitigation programs in 2013 and 2016, it becomes clearer that the agricultural industry not only relies on the state for their knowledge producing capabilities, but also because the state is able to implement policies favorable to the development of entire markets where they were not able to exist before due to capital constraints. This partially helps explain why certain "solutions" to reduce GHG emissions on farms are favored and promoted: some have markets and some do not. Where they do not, the neoliberal state needs to assist in forming them.

Since the solution to everything from fuel to climate crises in neoliberalism is to "just add markets," it is not surprising that the most popular solutions to confronting the climate crisis are market-based, or more specifically "carbon market" based. In 2022, the global carbon market was valued at over \$946 billion and it is only expected to grow (Zelljadt 2023). This is an incredible global moment of cognitive dissonance. In one breath, organizations like the IPCC say radical changes are needed to avoid a crisis and in the next, they insist that carbon markets, which only deepen the grip of neoliberalism on nature by commodifying and financializing

pollution, will get us there (IPCC 2022a; 2022b). Here, I turn to the state of California to highlight the ways states in the Global North have become differently powerful further into the era of climate change.

Section 6.2: Introducing Carbon Markets, Offsets, and the California Compliance Market

Fleshing out “what is a carbon market” is not an easy task. For myself, it took almost a year (and the assistance of many people working with/ within the world of carbon offsets) to learn the basic workings of these immensely complex schemes. To start, it is useful to differentiate between the two types of carbon markets: *voluntary* and *compliance*. The focus of this dissertation is *compliance carbon markets*, which are used to fulfill regulatory compliance requirements put forward by a state or states (Kollmuss, Zink, and Polycarp 2008). Specifically, I take a look at the California Compliance Market (CCM). In the case of California’s programs, entities that produce a high level of GHG emissions per year such as oil and gas companies, utility companies, factories, and other industrial facilities are *required* to lower their GHG emissions and this is the compliance obligation that makes these markets compliance markets. The regulatory body responsible for implementing and enforcing regulations across various states is the California Air Resources Board (ARB) rather than the EPA (ARB 2019).

Voluntary markets, on the other hand, are not regulated by states, but by third party organizations called “offset registries. The voluntary market has many different registries, but in the CCM, projects can only use three registries that have been pre-approved by ARB: the American Carbon Registry (ACR), Climate Action Reserve (CAR), and Verra (ARB 2023d). In these markets, the commodities being traded are offsets, also known as carbon offsets or carbon credits. This is another type of carbon market called a “baseline-and-credit” system. These

“credits” are understood as a reduction in GHG emissions in one place as substitution for continued/increased emissions in another (Newell et al. 2014). When used within voluntary markets, offset credits can be used by corporations to claim they have met “net zero” targets (Kollmuss, Zink, and Polycarp 2008). Net-zero targets, a form of neoliberal “corporate governance,” are voluntary promises made by companies to lower their GHG emissions to zero at some point in the future (Nugent 2021; Trouwloon et al. 2023). They are ideal for corporations as a form of climate change mitigation because these promises are non-binding and non-enforceable, a suitable alternative to more government regulation from the perspective of corporations.

As I learned in my interview with Verifier 2 (2022), in order to understand the current regulations of the CCM, we have to take a step backwards. The CCM is only one compliance market within a larger history of global compliance markets and the CCM drew on the design and policies of these markets to create the system that exists today (Kollmuss, Zink, and Polycarp 2008; Bigger 2015). At the heart of offset projects, there are the various protocols that contain all of the rules, regulations, and scientific methodologies used to create these projects. According to verifier 2 (2022):

There's also the clean development methodology (CDM) which is like the grandfather of all offset projects, period. That goes back to the Kyoto Protocol. CDM was set up so that you had an offset project in the developing world that would sell those credits to the developed world. In terms of balancing out, you know, greenhouse gas effects internationally. That kind of ended in 2020, sort of. But everybody else's protocols kind of go back to the original CDM protocol.

Indeed, the protocols used by the CCM stem from the Clean Development Mechanism (CDM) which was a part of the Kyoto protocol: the first international climate agreement that encouraged global GHG emissions trading, led by the United Nations (Hepburn 2007). This protocol was signed in 1997, sixteen years before California began operating their cap and trade system. The

Kyoto protocol operated until 2020, when it “kind of ended” and was replaced by the Paris Agreement (Leggett 2020).

One type of compliance market used by the CCM is the cap and trade program. In a cap and trade system, the state puts a cap on the amount of pollution that industries are permitted to release with the goal of restricting that cap more over time (ARB 2019). The commodities being traded are “allowances” which in this case, refer to emissions “allowed” by the state from a regulated entity such as oil and gas producers, refineries, and other large industrial facilities that produce a significant amount of GHG emissions. In theory, once given, the number of allowances cannot be increased or changed, but can be exchanged by the entities within the program. These allowances are bought and sold at auctions led by the state several times throughout the year. In practice, however, markets are not always predictable. For example, in 2016 and again in 2017, the state of California had a glut of allowances with no one willing to buy (California Legislative Analyst’s Office 2020). As a result, state revenue shrunk from \$500 million to less than \$10 million. In the first quarter of 2020, another occurred due to the economic downturn associated with COVID-19. During this period, state revenue dropped from \$600 million in the first quarter to \$25 million in the second quarter (California Legislative Analyst’s Office 2020; Brown 2020).

One issue that is becoming increasingly apparent in the era of “net-zero” is that there are no regulatory mechanisms in place to ensure that companies who are not subject to regulatory caps have a plan beyond offsets to reduce emissions and are following that plan (Trouwloon et al. 2023). Indeed, many companies are currently using offsets as the primary mechanism for them to reach net-zero emissions (Etherington 2020). According to the International Air Transport Association (IATA)(2021), a trade association for the airline industry, currently, the

airline industry relies on offsets for over 97 percent of their emissions reductions (figure 6.1). The IATA currently estimates that they will not even begin to reach the maximum number of offsets allowed by the state of California until 2050, the latest possible target to avoid climate catastrophe (IPCC 2022b).

Here is where it can get confusing: in their cap and trade system, ARB allows *regulated* industries to *offset a portion* of their emissions. According to ARB (2023):

Compliance entities may use ARB Offset Credits to meet up to 8 percent of their compliance obligation for emissions through 2020; 4 percent of their compliance obligation for emissions from 2021-2025; and 6 percent for emissions from 2026-2030.

Here is how this works. Regulated companies can emit a certain amount over the cap if they buy that same amount of offset credits from certain “environmentally friendly” projects selected by the ARB, which I discuss in more detail below. To provide a “real world” example, with offsets, Chevron, a large multinational oil and gas company, is can emit 50 more tons of carbon dioxide by purchasing 50 offsets from a CAFO with a digester and is still able to meet their compliance requirements in the state of California (Duke 2009). The idea is that by investing in these environmentally friendly projects which reduce or avoid emissions, regulated entities can pollute over the cap without facing any repercussions from the state. In a baseline-and-credit system, as opposed to allowances, there is no limit to the amount of offset credits that can be generated as long as they are invested in specific projects such as the one above. The regulated entity can use these credits themselves or sell them on the market for a profit.

What are the “projects” that enable polluters to offset their emissions? Offset projects can be divided into two categories: *carbon avoidance* and *carbon removal projects*. Carbon

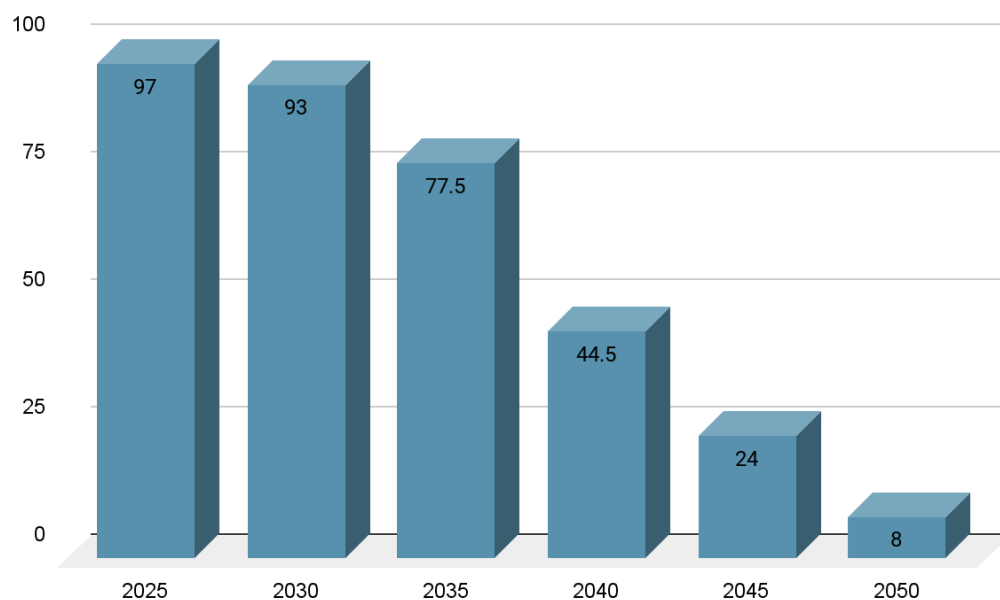


Figure 6.1: Estimations of Total Reliance on Offsets for Meeting Emissions Targets within the Airline Industry (International Air Transport Association 2022)

avoidance projects include funding the installation of renewable energy projects, increasing energy efficiency of existing technologies, switching to new “household devices” that reduce household energy consumption, such as inductive stoves, and funding new tools for household water management, particularly in the Global South where many communities have to boil their water to ensure its safety (Ecochain 2022). Carbon removal projects aim to actively reduce existing emissions rather than avoiding them. *In the CCM, only carbon removal projects are eligible for offset credits* (ARB 2023e). These include projects that use anaerobic digestion on farms, methane capture for coal mines, forestry and land use projects (avoiding deforestation, encouraging reforestation), rice cultivation projects, and ozone depleting substances (ODS) projects (Gunn et al. 2020). Each of these project types has their own “compliance offset protocol” within the CCM system (ARB 2023e).

The most common type of offset project used in the CCM are forest offset projects (Carbon Plan 2021). Recently, scandals within the forest offset program have brought the limitations of offset projects as a climate solution back into focus (Song and Temple 2021). In their analysis of 102 million credits within CCM’s forest offset program, the largest forest offset program in the US outside of the voluntary market, Carbon Plan (2021) found that almost a third (29 percent) of forest offsets in the CCM were over credited. In total, that was around, “30 million tCO₂e worth approximately \$410 million.” Overestimation led to the distribution of millions of “ghost credits” that did not correspond to actual emissions reductions.

At the center of this issue is the “magic math” involved in creating the methodologies behind generating, not just forest offsets, but all offsets. Before a project begins, the project provides a “baseline” estimate of emissions during a “business as usual scenario,” which are normal operating conditions. Credits are calculated based on the difference between the baseline

and the amount of emissions reduced. If the baseline calculations estimating emissions are incorrect, the project has the potential to vastly overestimate their climate impact and cash in on more credits than they actually earned (Broekhoff et al. 2019). In the case of forest offsets, the ARB relied heavily on existing calculations created by the voluntary offset registry, Climate Action Reserve (CAR), to create their baselines (Song and Temple 2021). However, these baselines did not take local ecology into account and were instead “broad averages” based on simplifications of US Forest Service data. In other words, these calculations ignored the complicated reality of forest ecosystems by assuming all the trees were absorbing carbon dioxide at the same rate when they were not. Ultimately, the baselines were set too low and as a result, projects were given many more credits than they actually earned.

Overestimation of credits based on emissions reductions also means that the inaccurate estimate of baselines can result in underestimation of emissions the project is actually producing. If we turn to the ARB livestock offset protocol (2014), for example, we can once again see this magic math at work. The livestock offset protocol (ARB 2014) features a page and a half long table of the “offset project boundary” which, according to ARB (2014): “...delineates the [GHG sources, sinks, and reservoirs] that must be included or excluded when quantifying the net change in emissions associated with the installation and operation of a device, or set of devices, associated with the capture and destruction of methane,” (14). In chapter 5, I discussed at length the current limitations of research on the negative health and environmental outcomes related to anaerobic digestion of animal manure. There are very few studies that seek to understand the impacts of the byproducts of these technologies, but the studies that do exist have concerning implications.

For example, Holly et al. (2017), in their study of emissions from digestate, found that over time during storage, nitrous oxide (N₂O) emissions increased by 81 percent, which ultimately canceled out the methane emissions that were reduced by the digester. Nitrous oxide is 300 times more potent than carbon dioxide and 10-15 times more potent than methane (Chao 2012). However, the “carbon accounting” of emissions within the process of manure digestion excludes N₂O from the baseline of every emission producing activity on the CAFO, even vehicle emissions (ARB 2014). This is particularly an issue because many of the vehicles used on farms, which include tractors and manure spreading tankers, run on diesel fuel which is a “dirtier” fuel than gasoline.

The forest offset scandal also highlighted that a central issue with offsets is proving *additionality*. “GHG reductions are additional if they would not have occurred in the absence of a market for offset credits,” (Broekhoff et al. 2019). Offsets only have value if projects reduce emissions more than they would without a carbon market in place (Kollmuss et al. 2010). If these projects would have happened anyway yet are used to claim *additional environmental compliance*, not only does this encourage the use of offset projects in the place of actual large-scale institutional change, but it also increases emissions, thus further worsening the effects of climate change (Broekhoff et al. 2019). When projects are not additional, they have the potential to give polluting companies the opportunity to present and legitimize their activities even when their emissions reductions are questionable and underscores claims of greenwashing (Polanski, Grau, and Garma 2010).

Thinking back to chapter 3, the relationship between verifiers and ARB is a clear example of neoliberal environmental governance, specifically privatization. To highlight the difference between marketization and privatization, I mentioned that it is useful to take a look at

who is paying who in these arrangements. Verifiers, or verification bodies (VBs), are fully privatized because they are not paid by the state, rather they are paid by the project developer themselves. Just like crop consultants who actively sold fertilizer at the same time they were tasked with consulting on the amount of fertilizer farmers should use, these privatized regulatory arrangements present clear conflicts of interest. Considering most of a verifier's job is based on their own subjective judgements, these conflicts are highly problematic (Smith 2019). The subjectivity of their work was highlighted by Verifier 2 (2022: 16):

I hate going back to ARB, but they're just the most, just the worst when it comes into this. They'll go, 'What did you do?' And I said, 'I did this, this, and this,' and they go, 'Well, did you look at this?' And I'll say 'no, the protocol says confirm regulatory compliance. That's it. It's that general. So I did a number of things and I felt like I did my due diligence,' and they'll say, 'Well, we're going to contact the state,' and I'll say, I'll just throw my hands up. Like, whatever. I don't even care. Like, just do whatever you want because, you know, they give you a guy- It's like telling you to go for a walk and you go for a walk down, you know, 12th, Street and I go, 'why didn't you go down 11th Street?' And you're going, 'Because you just said go for a walk. I'm not- I don't know what you want me to do.'

In the next section, I take a closer look at the actors within this neoliberalized nexus to understand how livestock offset projects are regulated *in the real world*. Specifically, I bring in interviews with verifiers and regulators in Wisconsin to show the limits of these projects as a meaningful tool to reduce GHG emissions within a deeply neoliberalized state.

Section 6.3: When Markets Become States: Regulation by Privatization in the "Offset Space"

In chapter 3, I discussed how neoliberalism has profoundly reshaped how the state regulates in two key ways. First, as theorized by Peck and Tickell (2002), neoliberalism encourages the state to "roll-back" or deregulate policies and programs that are focused on maintaining and improving the quality of "public goods" which includes the environment.

Deregulation was often, but not always, coupled with re-regulation, where states “roll-out” new regulations that promote *a neoliberal governance* which prioritizes the needs of the market above all other areas of society, including the environment. According to Peck (2001), this does not mean that the state is powerless, just “differently powerful.” Two forms of re-regulation that continue to be useful to describe the workings of the neoliberal state are marketization and privatization.

According to Birch and Siemiatycki (2016), marketization, “involves the introduction of markets and market forces into the state, primarily into its functioning, authority and legitimation,” (179). In other words, marketization is so foundational to understanding the neoliberal project because it encourages a shift in the most basic ways that the state “thinks.” Markets automatically become the answer, no matter what the problem is. A marketized state assumes that the best mechanism for curbing environmental problems is in the form of “soft” regulation such as *voluntary*, *market-based*, and *self-reported* regulation as well as *public-private partnerships* (Shamir 2010). With marketization, the state still has some control over regulatory capabilities rather than fully turning them over to the private sector.

Throughout the following section, I turn from a focus on marketization to privatization. Privatization is also key for the neoliberal project because it limits the direct influence and involvement of the state within the practice of regulation. I turn to privatization because all of the key actors involved in the regulation of CAFO offset projects, aside from the ARB and local regulators (who are often not involved as I discuss later on in this section), work purely within the private sector. There are three groups (aside from ARB) that carry out the creation, implementation, and enforcement of offsets. The first, which I mentioned above, are offset registries. Offset registries, “develop standardized protocols for project registration (to issue

carbon credits), keep track of available credits in the marketplace, and make sure that the environmental benefits associated with individual credits aren't being allocated to multiple entities," (Sullivan 2022). The registries have more of a regulator role in the voluntary market compared to the compliance market because they are the primary entity that monitors compliance outside of the verifiers. In the CCM, the ARB takes on that role.

The *project developer (PD)*, as shown in figure 6.2, is in many ways the "lead" on these projects. They have the most responsibilities in terms of project management, including on site operations, monitoring, reporting, and setting up the project in the first place (Kollmuss, Zink, and Polycarp 2008). In this arrangement, the project developer approaches the farm and either offers them consulting services for a fee, a fee and a portion of the revenues from selling offsets, or they can keep a part of the carbon credits themselves (Adcock 2010). Verifier 2 (2022: 11) described the relationship between the CAFO owner and project developers like this:

We've done literally over 100 livestock audits over the years and never once has the farmer actually done the calculations and the project. Like, farmer Joe is not going to read an 80 page protocol and, you know, get involved with the registry. So it's, it's always at least one other party that comes in and says to the farmer, 'Look, if you're eligible for offsets, we- this is what we do for a living. We set up stuff, you send us data, we have this agreement, you get paid X, we get paid X.' Whatever. And it works really well because there's been, you know, hundreds of offset projects.

After the developer sets up the project, they hire project verifiers that are accredited by the state of California to check that the project is following the livestock protocol (ARB 2022). The second job of the verifier is to ensure that the project is in compliance with existing regulations. According to ARB (2012: 2):

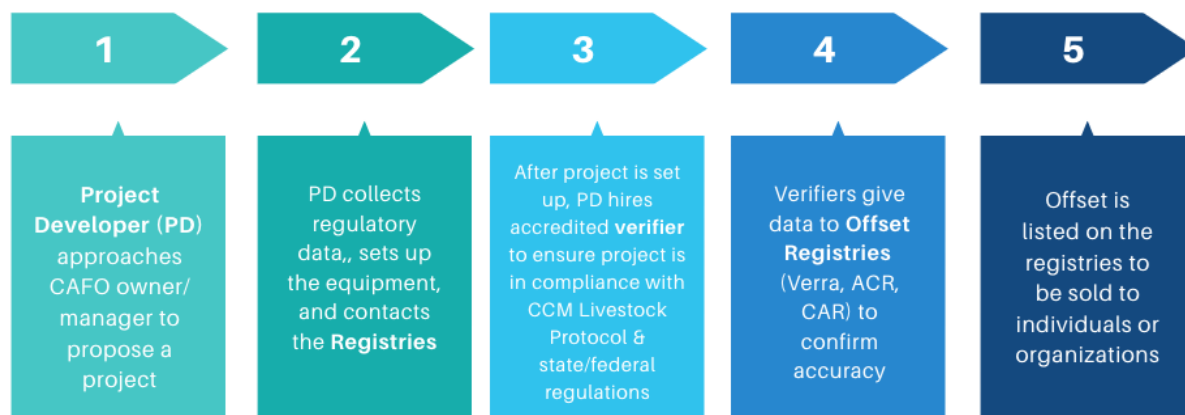


Figure 6.2: The process of setting up a livestock offset project (ARB 2013).

All compliance offset projects must be determined to be in conformance with all state, federal, and local environmental, health, and safety regulations applicable to the offset project location before ARB issues ARB offset credits... In addition, compliance offset projects may occur outside the State, and therefore, the regulatory conformance determination serves to ensure that projects credited under California's program are meeting applicable regulations in the various states.

It is the PD's job to monitor the CAFO during the course of the project and talk to the CAFO owner/ manager to make sure that they are following all regulations or else they could have the project's offset credits canceled by ARB in a process called "invalidation" which I discuss in more detail below (Bigger 2015; Smith 2019).

As I mentioned in the methodology chapter, I was unsuccessful in my efforts to find a project developer that was willing to speak to me. However, I was able to interview two verifiers. These verifiers work in very different organizations, but they had surprisingly similar responses to many of my questions. The first theme emerged when I asked them the basics of their jobs as verifiers. It was clear that they depend on many people within this process, particularly project developers, CAFO owners/managers and local regulators, to do their jobs correctly. According to Verifier 1 (2022: 2):

...So specifically when we're looking at the- So part of conformance, the conformance requirements, you know, offset project on a dairy farm, is to make sure that they comply with what is outlined in their CAFO permit. Specifically around the herd numbers... And then we get that information from the project developer itself. So the farm manager in- Also there's a project developer that kind of runs the offset project and helps the farm, you know, to get all documentation together. And so the CAFO permit comes to us by the project developer.

Verifier 1 understood the developer as largely responsible for doing the background research to ensure that they were compliant with the livestock protocol:

I mean I assume that when the project developer engages with the farm, there's understanding that they- Well there has to be some sort of attestation that- this is just what I'm thinking I'm not sure if it's correct- but I would assume that the farm manager must have to attest that the dairy farm is in compliance with all its permits to allow it to

operate. Otherwise the project developer wouldn't spend so much time on trying to get the offset project up and running for that year.

Verifier 2 was surprisingly candid in our interview. They brought up that one of the hardest aspects of their jobs was simply communicating with all of the actors involved:

Verifier 2: So the reason it gets a little complicated is because you have a third-party trying to understand the farmers' system and they like start two years before they even bring us in. And so by the time we get there, we asked the farmer the same questions they did but it's like two years apart. And farmers, God bless their hearts, are pretty busy and so sometimes they'll give you a different answer and then you're confused. Like okay well- And it's not like they're lying, It's like, you go to the developer and say, 'hey he's saying he did this, you said here that he did this.' And so that's- There's a lot of confuse- That's mainly the biggest-

D'Onofrio: The hardest part is just communication?

Verifier 2: Exactly. Because it isn't, you know- The farmers, they're busy, you know? They don't- And they don't really- They like, you know- They're carrying out their business and, you know, managing their manure is a big deal, but it's only one thing that they're thinking about and dairy farmers, especially they, like, work, 24/7. It's just insane.

On top of CAFO owners/ managers and project developers, they also depend on records and data from state-level regulatory agencies because most CAFO permits are regulated on the state-level (as discussed in chapter 3):

So we get the CAFO permit and then we also contact the state governments directly to make sure that there hasn't been any violations or any nonconformances with their permit that they're not tell- that the project developers aren't telling us, or the farm managers aren't telling us directly. So we do a check through the government to make sure that everything is what they're saying to us is correct. Or because, you know, they can give us these permits and then there might be something that's happened since and then we don't really know about it (Verifier 1 2022: 3).

Since CAFOs are so deregulated, finding the right people can be very difficult. For Verifier 1 (2022: 4):

Verifier 1: Sometimes we have project developers that will give us the names of people to contact in their state governments and other times, it's up to us to just randomly email someone or call the web, call the office from an internet search and try and find the right person to get in contact with. So I think in some way how detailed that third-party check could be is pretty dependent on the verifier. If that makes sense?

D'Onofrio: Yeah.

Verifier 1: Because you have to contact the office um or the state government um and then try and find the right person to talk to. Sometimes it has been difficult- and I don't think Wisconsin was one of those states- but sometimes you do get down this rabbit hole and then you find out that this other department- and I think this is to do with CAFOs- Actually I do remember in Oregon they had a different body that was managing some sort of Safe Water Drinking Act or something like that which I think it is considered to be a regulation that the farms need to be in compliance with as well for their surface water level. So I think there was a bit of difficulty in Oregon trying to find the right government department to go for that. But I think it all comes back to your experience as well. And once you are- um have done a lot of these livestock verifications in the US you kind of know who to contact and what government body in each state you need to look at.

It was very surprising to hear from the verifier that ARB does not offer any state-level guidance for verifiers because one of the central components of their job is to ensure compliance within a complicated patchwork of regulations that often vary from state to state. Without training, it is very easy to misunderstand regulations or, in some cases, know specific regulations exist in the first place. If the verifiers are not familiar with the context that they are regulating in, this makes mishaps related to oversight much more likely, particularly if they are not regularly in contact with regulatory agencies. But it turns out, ARB does not even have a list of state regulators to get in contact with. The same issue was identified by Verifier 2 (2022: 13):

If there's a state, let's take- Let me just think of somebody... Utah's a good example. Utah, there's no state environmental database, right? They have ECHO, which is the federal database. And then they have just random people. And so those are more complicated because now I'm, you know, email blasting every, you know, AG State person in Utah that works from the Department of Environment going, 'hey, there's a livestock facility out near Beaver and I need to know if they've had an environmental violation.' And so generally when we like have a new state, you gotta do these email blasts and it takes a while to find the right person. But then when you do, you just- Then we just email them and say, 'hey, this is who I am. This is what we're doing. Can you confirm?' Sometimes they answer, 'Yes, I can confirm. There was no violations. I'm in charge of this area.' Sometimes they say, 'You got to submit a Freedom of Information Act request, here's the website.' So then we go through that or they'll say, 'we have a state database online, just go there. We don't, we don't we're not going to give you yes or no answers over email.'

If ARB does not direct verifiers to the regulators they have to speak to as a part of their job, how do they know if they are talking to the right person? How will they know if they have accurate

information? Ultimately the answer here is not clear. The fact that ARB offers little guidance on who the verifiers are supposed to contact, I wondered what does ARB teach in their verifier accreditation programs? Since verifiers are fully privatized, they are required to pay ARB for a course that fulfills their accreditation requirements. Not much, according to Verifier 2:

It's just like- We went to their trainings and like they hired out their training to a third party and that party knew next to nothing compared to us. And so they're like, going through the training and we're like, 'That's wrong, that's wrong. You have no idea what you're talking about.'

This is another level of privatization. ARB not only chose to use verifiers as their “boots on the ground” regulators, but they did not even train them themselves. Verifiers, then, have an immense amount of discretion to push these projects forward despite this extremely low level of state oversight.

Another theme took me by surprise. In my interviews with both verifiers, ARB did not feel like they needed to teach the verifiers about local regulations and the verifiers did not feel like it was a part of their job to learn them despite the fact that their job was to establish regulatory compliance with local and state regulations in addition to the CCM livestock protocol. For example, after mentioning that the project developer is typically the party providing the permit to the verifier, Verifier 1 (2022: 3) said:

Verifier 1: And sometimes that might just include those pages that we need to look at because they are pretty detailed- um- as well. Uh...So, we don't go through the whole permit, I would say, to make sure it's in compliance because sometimes I mean we're just not trained in dairy operations to get everything *laughs*

D'Onofrio: Is that more of like the project manager's kind of job? To go through that?

Speaker 1: Uh...I would probably say yes.

In addition to their contention that it was not a part of their job description to learn about dairy farm regulations, Verifier 1 also claimed that their job was not to bring entities into compliance when they were found to be in violation of their permits. They described one case in Minnesota

where they discovered a CAFO who was applying to become an offset project was in violation of their permit:

Verifier 1: In this instance, when I contacted Minnesota Government, they didn't- they weren't aware that the farm operating with more cows than they should.

D'Onofrio: Oh, so you helped kind of bring them into compliance there.

Verifier 1: I'm not sure what actually happened on that.

D'Onofrio: Oh yeah. You moved on?

Verifier 1: Yeah that's kind of out of our responsibilities as a verifier, I suppose.

Verifier 2 (2022) echoed similar sentiments when they claimed that a central part of a site visit is to learn how the farm changed their manure management practices—"...we're looking at how the waste is being collected...how the effluent from the digester's managed, if solids are separated..." (14)—yet:

D'Onofrio: What kind of documentation are they required to submit?

Verifier 2: So, the most important things are going to be the amount of methane they destroy, how many cows are at the farm-

D'Onofrio: Okay.

Verifier 2: The, the baseline practice- The practice- How the manure was handled prior to the project.

D'Onofrio: Like their nutrient management type of stuff?

Verifier 2: Not really the nutrient management plans. Those are more like- Well you probably- I mean the only thing we use those for is confirming which oversight regulatory agency we can contact.

In other words, the verifier understood that part of their job was to ask how digestate was going to be handled, but, strangely, did not see the point in looking at the documentation that is supposed to include a plan for handling digestate. They clarified (15):

Like we all like- I don't get into detail- Like they probably- I actually don't know, you know. We- Cause- Uhhhh. Yeah, I should probably clarify this. Like we don't determine whether there's been a violation like, I'm not- Because we have a livestock project you can have in any state, right? I don't know what Wisconsin's dairy regulations say. All I ask is have you had an environmental violation?

This lack of engagement with the actual regulations of the CAFO was concerning after Verifier 2 shared this insight (14):

Like, I would say, like, I mean, we've done, you know, in the company history of like 15 years, we've done 1300-1500 audits, and like maybe 3 times we had one where we actually went to a site before the equipment was there destroying a greenhouse gas. It's very rare. So when you show up, everything is already there, so that hypothetical baseline of what was happening prior to the project doesn't actually exist. Do you understand? Like yeah there's no more release of methane from the lagoon because when I get there, the equipment is already there and it's already being destroyed.

The magic math is at work once again, but this time in the livestock sector. These comments beg the question, what actually is the role of a verifier? Later on in the interview, Verifier 2 revealed the answer (18 emphasis added):

...we'll say, 'look this has nothing to do with the project and [ARB will] say, 'Nope. We think it does,' and we'll say 'Okay, well I don't you know, you go do it.' And in the most extreme case, they've actually contacted somebody, I think it was a state of Wisconsin and they were like, 'Hey, we think this issue is a violation of your state law. And the Wisconsin people will be like, 'What? like, why how do you even look? Why do you even care? You're in California. Like it's our state, our state regs. We said it's not a violation. It's not a violation.' ARB will say, like 'No we think it is' and they'll be like, 'Okay, well we don't care what you think.' I mean, it's every day. I've taken this and they've just taken it to the extreme. And I think part of the reason was, is because like, that's their background, right? Like they do regs and so that's what they focus on. But to us, it's like, **well, the most important thing is the numbers.** Like those are what's important. You're issuing offsets, you should know how these numbers work and they don't.

This seemed familiar. Indeed, their description of this conflict came quite close to the way Regulator 1 (2022) recalled their experience working with ARB during a case of offset credit invalidation. It was at this point that I realized that Verifier 2 was one of the verifiers for Central Sands, one of the few offset projects to ever have their credits invalidated.

To take a step back, what is invalidation? As I have explained throughout this section, the job of the verifier, but also, in a sense, the project developer is to make sure that they are

following local, state and federal environmental regulations. If ARB finds out that these projects were not following regulations, they can initiate a process called invalidation (CARB 2012: 2):

The Regulation also includes a mechanism called invalidation that may be triggered after ARB offset credits have been issued. Even though ARB has a rigorous and multi-step review process prior to the issuance of ARB offset credits, subsequent new information may result in a determination that the ARB offset credits were generated from projects that did not conform to the requirements of the Regulation.

Invalidations cause immense conflict in the offsets world because they impact almost every group involved in the offsets market. They impact the CAFO and project developer because they lose revenue from the credits that were invalidated. But more importantly, the invalidation of credits means that any entity that received offsets from that CAFO has to find another way to meet compliance for the additional emissions they produced and assumed would be covered by the offset project. Figure 6.3 provides a visualization of some of the CAFOs in Wisconsin involved in the production of offset credits and the compliance entities that purchase these credits. A few of these entities include Chevron, Shell Energy, and Proctor and Gamble, as well as a few other energy companies, refineries, and utilities (Carbon Plan 2023).

Verifier 1 noted that, in general, validations are “infrequent” at least in the context of the CCM (2022: 13). One of these projects is shown in figure 6.3 below. Central Sands Dairy in central Wisconsin. For the rest of this section, I focus on the saga of Central Sands. Central Sands Dairy, which is located in the Central Sands region of Wisconsin, has experienced their fair share of conflicts with neighbors. In 2007, Central Sands Dairy moved onto a plot of land that used to be used for vegetable farming across the street from several families (Seely 2014). One family living near Central Sands noted that, “The smell and the ammonia from the liquid manure was so bad his son refused to bring Murray’s grandchildren to visit,” (Seely 2014). The Millers, who also lived across the street from the farm claimed that the fumes from the lagoon

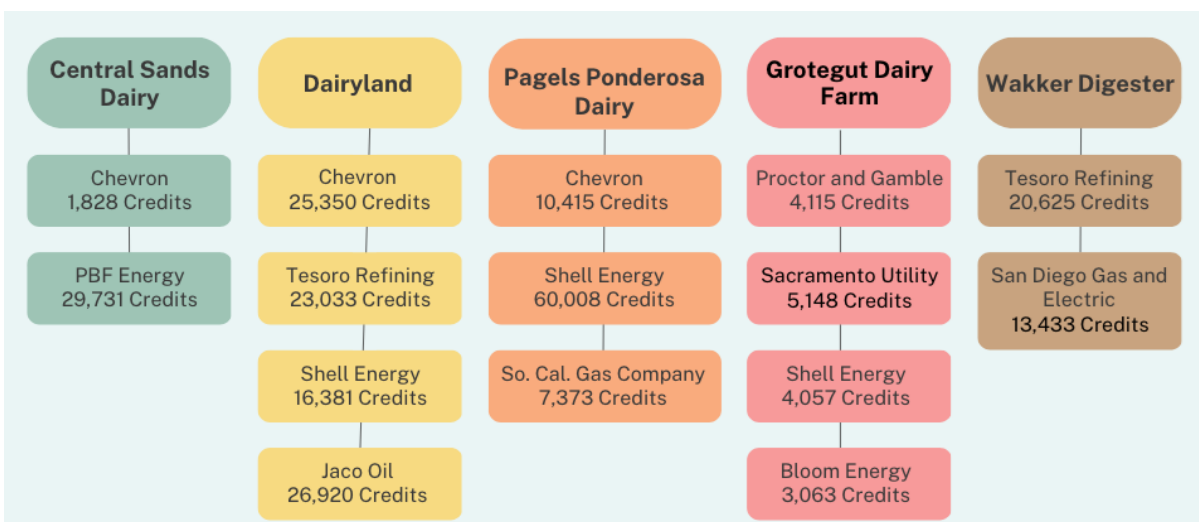


Figure 6.3: Recipients of Compliance Credits from Wisconsin CAFOs (Carbon Plan 2023).

were “almost too powerful to ignore.” Diane Miller noted that, “We had so many flies it was like that scene from ‘The Exorcist.’” However, the owner of the CAFO, Jeff Sommers, said there was nothing to worry about because “He said [the farm] now uses a biodigester that reduces the level of pathogens in the manure. He also said the farm follows a nutrient management plan, required of all CAFOs that prevents overapplication,” (Seely 2014). However, this “biodigester” clearly did not stop these issues. Five years later, 81 residents around Central Sands Dairy sued them for knowingly contaminating groundwater for decades (Madden 2019).

According to ARB (ARB 2020), throughout the entire year of 2018, ammonia concentrations collected from the groundwater around the farm were significantly higher than the enforcement standard in Wisconsin. To give a sense of how much ammonia was present in their groundwater at the time, the enforcement standard for ammonia was 9.7 mg/L and ammonia concentrations from the groundwater at Central Sands was 56.4 mg/L. By March of 2019, the WDNR issued Central Sands a Notice of Violation (NOV) and scheduled an enforcement conference with the CAFO. ARB did not become aware of this NOV until almost a year later, in February of 2020. However, as the project was undergoing its invalidation audit by ARB, the project designer, Camco Offsets LLC, submitted comments to ARB alleging that based on the WDNR’s own policies, this could not be a violation, thus not an invalidation (ARB 2020). In July of 2020, ARB reached out to the WDNR to confirm that this was the case. The WDNR replied (5):

...these allegations have not been confirmed by judicial review or by an admission by the regulated entity and, therefore, remain allegations. The July 1, 2020 closeout letter reads, ‘Compliance with the terms of Section 3.9 of the Permit and groundwater monitoring required under Section 2 of the Permit resolves the allegations in the NOV.’ WDNR closed the NOV because the permit has become the vehicle for resolving the allegations of noncompliance to the satisfaction of the department. This is consistent with our stepped enforcement policy which seeks to resolve disputes over allegations of noncompliance at the lowest level.

To go back to chapter 3, environmental regulations in Wisconsin dramatically differ from environmental regulations in California. As a part of sweeping neoliberal de/reregulation in 1995, the state of Wisconsin eliminated the ability of the WDNR to use their own discretion to issue citations for environmental violations. The new enforcement process that followed was called “stepped enforcement.” The stepped enforcement process is an extremely informal process that gives the CAFO many, many chances to get into compliance before they face any type of regulatory intervention. And in this process, NOV’s are not the same as an actual admission of noncompliance, which California is seeking to establish the conditions of an invalidation.

Still, *it was California’s program*. Regardless of Wisconsin’s convoluted regulatory process, ARB saw it as a violation of their permit. In response, they administered a scathing determination that ultimately undermined Wisconsin’s existing regulations (ARB 2020: 6):

While the documentation provided to CARB by both the APD and WDNR show that the NOV has been closed and resolved to the satisfaction of WDNR, it does not support the APD’s claim that the project was in conformance during the period that violations were alleged. As provided in section 95973(b) of the Regulation, a “project is considered out of regulatory compliance if the project activities were subject to enforcement action by a regulatory oversight body during the Reporting Period, although whether such enforcement action has occurred is not the only consideration ARB may use in determining whether a project is out of regulatory compliance.” A NOV is part of the enforcement process. Furthermore, as noted in the provision cited above, enforcement action is not the only consideration CARB may use in determining a project’s regulatory compliance status. Here, the evidence shows that the state regulator found documented concentration exceedances. Not all enforcement cases are proven in court or involve specific admissions of violations. To reflect this, and to ensure the protectiveness of CARB’s offsets program, CARB’s Regulation allows CARB to determine regulatory noncompliance has taken place based upon other considerations as well. Based on its review of the documentation and evidence during this invalidation investigation, CARB concludes that the dairy was out of regulatory compliance in 2018...

ARB correctly noted that Wisconsin had a uniquely incapacitated agency that is tasked with enforcing environmental regulations by highlighting that, in most states, environmental violations do not have to be proven in court nor do they require admissions of guilt. As a result,

ARB effectively ignored the regulations of Wisconsin and voided a portion of the offset credits collected by Central Sands during that period.

When I interviewed Regulator 1, it was clear that they were still frustrated with how ARB handled the Central Sands invalidation two years later. Part of the reason this process was so frustrating for WDNR was because ARB was pressuring them to estimate the amount of days Central Sands was out of compliance. However, as I highlighted above, that is not how the system in Wisconsin works (12):

They're trying to get us to commit to like a certain number of days or time period of alleged non-compliance. Those conversations last a long time. Because the answer they want from us is like, 39 days. That's it. And instead what we say is like, 'you know, here's our inspection report that occurred on this date and here's the administrative focusing on compliance on this date. We had a meeting on this date and like these are the dates that we come up with and that's- we're not going to try and interpret any farther,' and they really try and get us to.

But they were also hesitant to make these decisions because they understood that CAFO owners could lose a significant amount of money if these credits were invalidated (13):

Now, we've got a total of like 75 days that have passed between a one day in the field unlawful discharge and a 74 day administrative process to review and discuss their discharge. So if you're potentially making or losing a thousand dollars a day in carbon credits, one day versus 75 days, big difference. In those events, we have a ton of back and forth between all these parties and DNR to try and explain that administrative process and why it took 74 days for these different events to occur, and whether you're actually in non-compliance during that time or not... We just don't want to be accus- There's so much money on the line.

It was at this point that they were quite candid with me and mentioned that Central Sands was *still* leaking ammonia into the groundwater from a manure pit. This time, the ammonia level *exceeded 140 mg/L (17)*. This regulator in particular was interested in trying to use the offset program to bring CAFOs such as Central Sands back into compliance *by telling them how much money they could be making if they get back into compliance and join the offset program (18)*:

What I'm really interested in is how the potential loss in revenue to a farm could or couldn't motivate them towards compliance. So I have no idea how much income they've lost out on since early May 2019 because in our violation history, there's three NOVs and two of them cover this discharge to groundwater from the manure pit and we make it clear in the second one that since there has not been the action that was required in the permit to address this- since that like that thing never happened, they were supposed to modify the way storage facility- that the discharge we alleged never ceased or like the there's no gap in non-compliance. So I wonder how much money they lost since May of 2019 to date, and it's not like... We haven't resolved the case, either. It's still an open enforcement case. We're trying to figure out, you know, it's an unresolved enforcement case.

The regulator assumed that ARB would know that Central Sands was leaking into groundwater, thus was losing money, but at the time I was not sure if this was actually the case.

After this interview, I went to the ARB Offset Issuance Table: a database updated weekly by ARB that contains all of the offset projects receiving compliance offsets from the beginning of the program until today (ARB 2023b). When I looked at the period we discussed in the interview, it became clear that Central Sands was earning credits the whole time. Since the WDNR had no contact with ARB outside of these invalidations, at that point, it was unclear if ARB knew that Central Sands had collected credits with an active leak of raw animal waste into the groundwater of central Wisconsin. I learned more details about this later on when ARB issued Central Sands their *second* invalidation in March of 2023, 9 months after discovering their invalidation myself.

According to ARB in the final determination (2023f) of the investigation of Central Sands, the project designer, Camco Offsets LLC, was the first to notify ARB that Central Sands was once again in violation of their permit on May 5, 2022. But the violation handed over by the project developer was from December 8, 2021. In Wisconsin's stepped enforcement process, this made it all the way to the enforcement conference stage. And ARB did not contact the WDNR to confirm these details until December 22, 2022. On January 10, 2023, the WDNR confirmed that

in that conference, they re-opened a previous notice of violation because Central Sands never addressed the same leak that caused their first invalidation in 2018. In other words, at Central Sands Dairy, they were able to have an underground leak directly into groundwater that dramatically worsened between 2018-2023 and despite the numerous actors involved in the process of checking their regulatory compliance, none of them did anything to bring the CAFO closer to compliance.

During Central Sands' first invalidation, ARB invalidated a small portion of credits because of issues with determining the amount of time they were "out of compliance." Only 4,896 out of 15,002 credits were invalidated (ARB 2020). However, for the invalidation in 2022 ARB invalidated all 13,040 credits they had for that crediting period (ARB 2023). This was almost three times the amount of credits that were invalidated the first time around. However, as shown in figure 6.3, this was nowhere close to all of their credits (Carbon Plan 2023). The leak in their lagoon was active from 2018-2022, but because ARB only invalidated a portion for the 2018 period, *this means that Central Sands was still able to cash in on 9,613 credits during a period when they were leaking manure directly into local sources of groundwater.*

Section 6.4: From Offsets to LCFS- Biogas and the "Manure Gold Rush" in Wisconsin

One of my two central research questions is this: *Who and what is driving digester research, development, and adoption on dairy CAFOs in Wisconsin and the US?* Since 2020, many CAFOs in Wisconsin have gradually switched out the offset program into another program within CA's carbon markets: the low carbon fuel standard (LCFS). Table 6.1 below shows the

**Table 6.1: Digester Projects in WI producing credits for CCM
(AgSTAR 2022b; ARB 2023b; 2023c)**

Project Name	Digester Start Date	# of Cows	Biogas Uses	USDA Funding	Switched to LCFS?
Holsum Dairy - Irish Road Digester	2004	4000	Pipeline gas	Yes	
Green Valley Dairy Methane Reduction Project	2006	3900	Cogeneration	Yes	X
Holsum Dairy - Elm Road Digester	2007	4000	Pipeline gas	Yes	
Central Sands Dairy, LLC Digester	2008	3900	Electricity	Yes	
Grotegut Dairy Farm, Inc. Digester	2009	2400	Cogeneration; Compressed Natural Gas	Yes	X
Pagels Ponderosa Dairy Digester	2009	4600	Electricity	Yes	X
Dairy Dreams (Pagel)	2010	3000	Electricity; Pipeline Gas	Yes	X
Maple Leaf Dairy East	2010	2000	Cogeneration; Compressed Natural Gas	Yes	X
Maple Leaf Dairy West	2010	4000	Electricity; Compressed Natural Gas	No	X
Dairyland Digester	2012	3000	Cogeneration; Boiler/Furnace fuel	Yes	
Deer Run Dairy Digester	2012	1700	Pipeline Gas	Yes	X
Wakker Dairy Digester	2012	2100	Electricity	No	
Dallmann East River Dairy Digester	2012	2400	Pipeline Gas	Yes	X

CAFOs in Wisconsin that have switched over from offsets to LCFS. All of these switches happened over the last 3 years.

The focus of LCFS is much simpler than offsets. With LCFS, it is all about fuel. According to ARB (2017:3), “transforms and diversifies the fuel pool in California to reduce petroleum dependency and achieves air quality benefits.” The point of LCFS is similar to the federal RFS program, to lower the “carbon intensity” (CI) of fuels used in the transportation sector in California. In the most simple terms, carbon intensity refers to the amount of carbon dioxide that is released into the atmosphere when the fuel is burned (Jaller and Matthews 2021). Like the “cap” in the cap and trade program, in LCFS, ARB sets new “benchmarks” every year which get lower and lower with the goal of gradually replacing fuels that have a high CI with fuels that have a low CI. For example, looking at figure 6.4 below, each fuel starts at the same point and carbon intensity can be identified based on whether the line moves to the left, meaning a negative carbon intensity (which suggests this is a less dirty type of fuel) or to the right, an indication of high CO₂ emissions. Here, we can see that many fuels considered to be “renewable,” particularly ethanol, still have high carbon intensities compared to other renewable fuels. In figure 6.4, the renewable fuels with the lowest carbon intensity, by a significant percentage, are compressed natural gas (CNG) and liquified natural gas (LNG), both of which are a product from digesters on CAFOs. LNG and CNG is now being “rebranded” by actors within the agricultural nexus and the fossil fuel industry as “renewable natural gas.” Chevron (2023), for example, claims that, “Renewable natural gas can, one day, help reduce the life cycle carbon intensity of transportation fuels while meeting the world’s growing energy needs.”

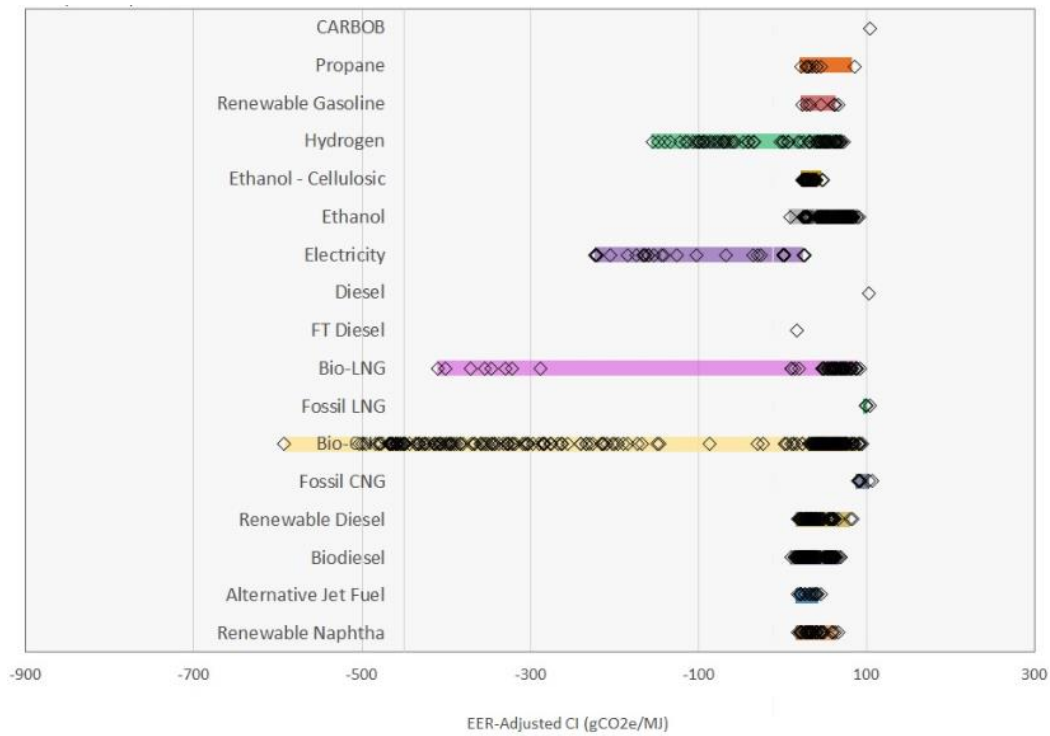


Figure 6.4: Carbon Intensity of Fuels (ARB 2023)

The LCFS first regulation was approved by ARB in 2009 with the goal of reducing the CI of vehicle fuels in the state by 10 percent by 2020 (Griffin, Saville, and MacLean 2016). The regulation was updated by ARB in 2011 and again in 2015, but the biggest changes that propelled LCFS into the national spotlight happened in 2018 (Chong and Ng 2021). The new LCFS, which went into effect on January 1, 2019, not only increased the goal from 10 percent to 20 percent of fuels in the state, thus increasing the demand for low CI transportation fuels, but it also extended the lifespan of the program to 2030. At the same time, the federal RFS program was struggling. After the new LCFS regulations passed, investors saw LCFS as a more secure long-term investment than RFS. According to the Dow Oil Price Information Service (Barber 2019 emphasis added):

The decision by California legislators and regulators last year to extend the LCFS by 10 years to 2030 and double the level of carbon reductions to 20% gave investors one of the first things they look for when deciding whether to finance plants – *will a market for the fuel be there when the facility is ready to produce its first gallons?* The fact that California decided to extend and expand the LCFS came at the same time the RFS was under assault from a record number of small-refinery exemptions and White House sponsored talks that included discussions of a price cap on RINs credit prices.

In the case of RFS, many of these uncertainties were political and it was unknown how long they would resolve.

Since the LCFS program expanded, there has been tremendous growth in the manure digester industry. We can see this in figure 6.5, below. From 2008-2013, the years following the biofuels boom of the early 2000s, there was a steady increase in the number of digesters on farms. In 2008, for example, 33 new digesters were installed that year alone. Between 2014-2018, the installation of new digesters slowed way down. In 2014, 2017, and 2018, only 10 new digesters per year were installed. In 2016, the smallest number of digesters (4) were installed since AgSTAR started collecting data in 2000. However, after the passage of the new

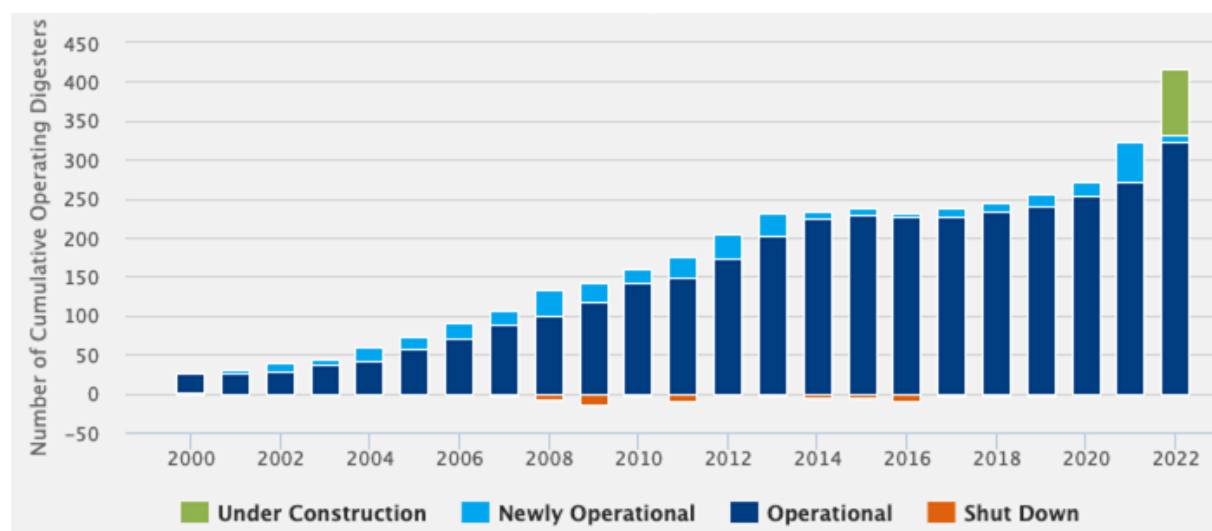


Figure 6.5: Number of Manure Digesters in the US 2000-2022 (AgSTAR 2022)

LCFS standard in California, the number of digesters in the US steadily increased. In 2021, there were 50 newly operational digesters. This is the highest number of new digesters added per year in the history of AgSTAR's program. And in 2022, AgSTAR had to create a new category: digesters under construction. Here, it is important to point out that this data does not reflect current numbers because AgSTAR has not added new data since the middle of 2022. That means that it is likely that many more than 85 digesters were under construction and preparing to operate over the last year.

But why? Why are people flocking to LCFS in droves all of the sudden? Why are farmers falling over themselves to switch from offsets to LCFS? Once again, I bring in the verifiers.

According to Verifier 1 (2022: 9):

I think a lot of project developers actually- It maybe was a lot of livestock projects- I cannot really remember, but I feel as though when the LCFS market started up in California, that a lot of the compliance based offset projects entered or changed to enter into the LCFS market because they could get so much more money than livestock projects under the California market.

This was also noted by Verifier 2 (2022: 10):

All of the ARB offset livestock projects have progressively over the last two or three years, whoever can will switch to LCFS because even though it might cost five million dollars for a skid to clean up the methane and inject it into pipeline in the middle of the Midwest, they can actually make it back fairly quickly, which is just insane to me. But it's that- That's definitely been the progression.

They also noted, "The LCFS market is like, I mean, *it's like striking gold*. Like those credits, the amount of money that's, that's transact- you know that's transacted in that market is- It's mind-boggling compared to, compared to offsets," (Verifier 2 2022: 6 emphasis added). To give a sense of how much the difference is, Verifier 2 gave several examples (8-9):

So like people tell us that they have like a landfill project and 'I like- Yeah I can't even get 50 cents a ton,' and then somebody from a forest project- 'but yeah we're getting \$20

a ton.'... So there's this huge range of offset credits, and then the LCFS, like, I thought, I don't even know what the range on that is anymore. I just can't- We- I don't even care. I mean it just- It was- Somebody told me like, you know, a couple months ago or last year, 'like yeah, it's like a \$200 a credit.'...There's literally so much money there that it really doesn't matter.

This phrasing used by Verifier 2 was not unique. Throughout the research process of this dissertation, I kept hearing this reference to “gold,” whether it was describing the creation of LCFS credits using digesters as “striking gold” or referencing the latest digester boom which is dubbed the “manure gold rush” (Smith 2022; Fu 2023; Dvorak 2022). Ultimately, CAFO owners and project developers were rapidly refitting CAFOs for RNG production because regardless of the costs to set up, they were making so much money it did not seem to matter.

But the benefits of LCFS compared to offsets go beyond money for actors working within CA’s marketized environmental programs. LCFS projects are significantly easier to set up than offset projects since the project is not trying to “offset” some type of pollution. This was highlighted by Verifier 2(6):

It's much much easier. It's... It's just- It's a lot less paperwork and red tape because it's just simply numbers and accounting and it's at the end. You're just like, 'yes, you are delivering a less carbon-intensive fuel than traditional gasoline diesel.' Like it's very straightforward. Where's offsets offsets are more like, 'this is what you would have done but you did something else based on this decision and you're not legally required to do it.' It's way more of this hypothetical philosophical approach whereas LCFS is just straight. Here's the carbon intensity of your fuel compared to what it is for traditional gasoline and Diesel and therefore you get this credit.

In other words, LCFS projects not only make significantly more money than offsets, but they do not require an in-depth environmental review because they are not subject to additional requirements at all.

As more and more CAFOs switch to LCFS, a program with less stringent environmental requirements, several CAFOs with serious records of regulatory violations have begun to join the

program. In fact, seven CAFOs in Wisconsin have taken on LCFS projects when they had never received offset credits before. These CAFOs include Rosendale Farms, Clover Hill Dairy, New Chester Farm, Jerseyland Dairy, Statz Bros Farm (which includes another farm), and Kinnard Farms. Kinnard Farms in particular is very interesting because the farm is currently suing the WDNR. Between 2012-2021, the WDNR and Kinnard farms were tied up in a case that made it all the way to the Supreme Court of Wisconsin. According to Clean Wisconsin (2023):

When its existing permit was set to expire in 2012, Kinnard Farms asked DNR for permission to expand its facility and add 3,000 cows. DNR not only approved that request, it also failed to add stronger standards to the permit to address the ongoing, serious groundwater contamination situation in Kewaunee County. A group of Kewaunee residents challenged DNR's decision. Following an evidentiary hearing, an administrative law judge (ALJ) ruled that DNR's decision amounted to a massive regulatory failure, and DNR should have included conditions to address water pollution.

In May of 2022, after the Supreme Court ruling, the WDNR started flexing their regulatory muscle and entertaining the idea of subjecting other CAFOs besides Kinnard Farms with groundwater monitoring requirements for their wells. This time, it was for Gordondale Farms, a CAFO with 2500 cows which also has a digester (WDNR 2020). In the surrounding communities, over half of wells have tested over the legal limit for nitrates (Hickman 2022). And in 2020, neighbors contacted the WDNR to challenge the conditions of their permit because it did not do enough to ensure their drinking water sources were not contaminated. The *Wausau Daily Herald* reported as follows when the WDNR held a hearing to announce these changes (Hickman 2022):

At the meeting, residents from Nelsonville spoke out unanimously in favor of the permit modification, many citing health problems they or family members had experienced that could be tied to the nitrate pollution...Bailey, for example, said she, her husband, 16-month-old baby and dog all suffer from hypothyroidism, which she believes is connected to the nitrate pollution. Meanwhile, Lisa Anderson, a Nelsonville resident who has headed up many of the community's efforts to change Gordondale's permit, said her neighbor could not be at the hearing because he was undergoing treatment for a cancer diagnosis she believes could also be connected to nitrates.

The head of Gordondale farms disputed these claims, noting that maintenance, well-testing, and improving nutrient management practices to avoid groundwater contamination had already cost the facility over \$150,000. The only other person at this meeting who was against the challenge to Gordondale Farms' permit was Adam Onan, the manager at Central Sands Dairy. Onan insisted that the DNR was, "on the brink of putting us out of business." But as a resident noted, "Most businesses with such a high risk of environmental contamination would consider such monitoring as a cost of doing business," (Hickman 2022).

Here, I would like to bring back Verifier 2. At the beginning of our interview, they noted that, at least in the case of offsets:

I've never seen anybody with an offset project that was like, they had an environmental violation that was just totally egregious in like a clear, just middle finger to the environment. Like that just doesn't happen. People who are doing offset projects are already people that are sort of advanced in thinking like they're not, you know people- You know, if you don't care about the environment, you're probably not going to sign up for an offset project.

I am still not sure if it was good salesmanship or blind optimism, but this was certainly not the case for Central Sands. Despite their long stint as an offset project, they knowingly leaked manure into the groundwater for five years and this verifier was there from the very beginning.

What happened to Central Sands? Did the offset program ever bring them into compliance? As I was completing the dissertation, I checked the WDNR's online CAFO database to find out. In November 2022, Central Sands started moving all of the cows off of the CAFO (WDNR 2023). I emailed Regulator 1 because I was unsure if I understood the documentation correctly. They responded within less than ten minutes that, "Central Sands Dairy ceased dairying operations last fall. However, they still have the WPDES CAFO permit, it

hasn't been discontinued or terminated. Nor has there been a formal request to discontinue/terminate the permit from Central Sands.” One can only conclude that Central Sands shut down because they could not afford to actually be in compliance. This is a central issue with CAFOs in the era of climate change: up until this point, CAFOs have not had to be in any type of actual regulatory compliance in terms of monitoring and reducing their air and water pollution. Building on decades of the power of the state/science/industry nexus, powerful farm corporations and the organizations that represent their interests have used their influence to avoid both air and water regulations. As a result, agricultural pollution has inspired the creation of environmental social movements in rural communities across the US. Since the very beginning of the history of digesters, they were used to end the conversation with rural communities around pollution concerns

Instead of following the judge's order, the WDNR claimed they did not have authority to do so. In response, Clean Wisconsin sued the WDNR in 2012. It was not until 2021 that this case started to be resolved. The Supreme Court recognized that it was the WDNR at fault here for taking their interpretation of the limits of the WDNR's enforcement capacity to the extreme. They had the authority to impose limits the whole time, but much like the EPA, chose not to. Instead of following the court order, Kinnard responded by suing the WDNR (on Earth Day) to stop them from imposing water monitoring requirements. According to Evan Feinauer, a Clean Wisconsin staff attorney (Holmes 2022): “Kinnard is opposing the very basic step of checking to see if manure runoff is impacting the water supply.” Once again, here we can see the limitations of marketized environmental programs as states further entrench the problematic environmental practices of CAFOs into a new fuel regime.

Chapter 7: Conclusion

Section 7.1: Key Research Questions and Summary of Findings

Q1- How are CAFOs in Wisconsin with long histories of noncompliance able to participate in and benefit from California's carbon reduction/market programs which require compliance to participate?

As I have discussed throughout this dissertation, compliance with state and federal regulations is the principal way that entities within California's offset program gauge the environmental record of facilities in order to identify if they are a chronic polluter or have any egregious environmental violations. I highlight in chapter 3 that CAFOs are not only deregulated on the national level, but also on the state level. Actors within carbon markets— including ARB— have claimed that verification is a transparent, enforceable, scientifically accurate, and efficient way to ensure that offset projects are not causing local environmental harm while collecting “green” credits. But the environmental records of most of the CAFOs involved in the program in Wisconsin show that they already have very long “rap sheets,” full of environmental harms both before and during their involvement in carbon offset programs (SRAP 2015). Additionally, the verifiers I spoke to expressed sentiments that contradicted many of these qualities. In breaking down these contradictions, this dissertation highlights the limitations of neoliberal environmental governance, particularly the marketization and privatization of state functions since the 1980s, in the era of climate change.

Indeed, the point of this dissertation is to challenge the notion that the CAFOs in Wisconsin with invalidations are simply “bad apples” in an otherwise good program. Wisconsin's current environmental regulation around CAFOs prioritizes keeping the peace

between the WDNR and CAFO owners over actual environmental outcomes and the production of environmental inequalities. The lax regulation in Wisconsin in the context of neoliberal carbon credit governance from California is so weak and informal that the system fosters a *culture of noncompliance*. Wisconsin's "stepped enforcement" program meets the goal of conflict avoidance. It fosters a non-adversarial process that the WDNR can use to coax CAFOs into doing incremental actions that may result in the violation being resolved. Crucially, this process allows pollution problems to persist without being addressed for long periods of time. Minimal "stepped enforcement" plus a significant time lag are essential parts of the neoliberal system of governance and reinforce the culture of noncompliance.

It was not until I conducted interviews that I understood the extent to which the WDNR was hamstrung by neoliberal policies. Going back to an important conjuncture in the neoliberalization of environmental regulations in Wisconsin in 1995, I found that the new regulations that were implemented by the conservative government of Wisconsin effectively incapacitated the WDNR. These regulations undermined the ability of the WDNR to deploy the most basic tool of environmental enforcement for the state— identifying and sanctioning environmental violations. Interviews of regulators at the WDNR in conjunction with interviews of verifiers, both of whom had extensive experience verifying CAFOs in Wisconsin were especially revealing about the content and effects of neoliberal governance. These interviews showed that California's cap and trade program leaned further into the use of privatization by integrating a new conglomeration of privatized entities that were allowed to take on the role of the state. Although these private entities claim to see and act like a state, because of their role as market actors, verifiers have serious limitations in actually carrying out these state-like functions. While regulators in Wisconsin were also restricted in their ability to carry out regulations, that

was due to actual policy restrictions that were created in the 1990s rather than the self-imposed limitations of the verifiers.

First, I discovered that there is a disconnect between the role of verifiers within the offset program and how the verifiers perceive *their own roles as regulators*. This perception is important to elaborate on because, aside from certain tasks such as checking equipment, verifiers have an immense amount of discretionary power to approve projects in spite of their lack of training on state-level regulations and regulatory agencies. Specifically, there was a disconnect between their roles as a market actor and also a privatized “state” actor. Both of the verifiers I interviewed did not feel compelled to bring entities into compliance with the law. They understood this task as outside the scope of their job duties. Indeed, they both directed my attention to the project developers who were notably unwilling to be interviewed. But the large number of actors involved only reinforces the lack of accountability built into the regulatory process. If it is not clear whose roles are whose, it is easier to enable the continuation of a system where no one is held accountable for their failures.

As I discussed above, the lack of enforcement is a self-imposed limitation on the regulatory efforts of verifiers. The reason I conclude this lack of enforcement is part of a wider culture of neoliberal noncompliance is that this practice by private verifiers is not unique. It occurred at the EPA and the WDNR as well. In fact, ARB seems to want to regulate these projects *more*, but is routinely met with resistance from project developers and verifiers. But simultaneously, this is a dimension that California built into their market based programs. Here, we can see why this entanglement of third-party regulators and public-private partnerships (a function of marketization of the state) undermines actual state regulation: ultimately these parties are not the state, but market actors. Verifier 2 discussed this explicitly when they noted that

although they are working for a compliance market, they were continually frustrated with ARB because they themselves are not a regulator. Rather, according to this verifier, “well, the most important thing is the numbers,” (personal communication 2022). By this, they identified themselves as primarily market based actors whose main job is to verify specific numbers used within market based programs, not state regulations.

Indeed, despite the fact that noncompliance with local regulations is the reason why invalidations happen in the first place, the verifiers I spoke to agreed that understanding local regulations is *not* an important part of their job. ARB does not familiarize them with the patchwork of environmental regulations on CAFOs across the US during their training and does not require knowledge of them as a component of verifier certification (personal communication 2022). ARB also provides minimal assistance guiding verifiers to the correct agencies and actors they need to access in order to confirm the CAFO is not a particularly egregious polluter. Indeed, apart from cases of invalidation, regulator 1 had never been contacted by a verifier. In fact, the only other regulator that was contacted had the lowest ranked position of all of the regulators I interviewed. They worked in enforcement and called themselves a “glorified poop cop” (personal communication 2022). And at the same time, regulators in Wisconsin did not understand too much about the programs themselves, what their requirements were, and which CAFOs even had projects on them (personal communication 2022).

Ultimately, this was a central issue in the process of invalidation of credits from Central Sands. The invalidation process was so complicated because California did not understand that a notice of violation was, in fact, not a violation in Wisconsin. In the first invalidation, this caught ARB off guard. They did not know how to reconcile the regulations of these two states. I noted

above that because of Wisconsin's stepped enforcement process, alleged violations take a long time to resolve. This was highlighted by Regulator 1 (personal communication 2022):

Now, we've got a total of like 75 days that have passed between a one day in the field unlawful discharge and a 74 day administrative process to review and discuss their discharge. So if you're potentially making or losing a thousand dollars a day in carbon credits, one day versus 75 days, big difference. In those events, we have a ton of back and forth between all these parties and DNR to try and explain that administrative process and why it took 74 days for these different events to occur, and whether you're actually in non-compliance during that time or not... We just don't want to be accus- There's so much money on the line.

For the first invalidation, ARB continued using the Wisconsin regulations as the "standard" of compliance. And in using these regulations, the outcome was clearly more favorable for CAFOs since only a small portion (4,896 out of 15,002) of Central Sands' credits were invalidated the first time around. Indeed, project developers used Wisconsin's regulations to effectively argue that California and their regulations did not have power in Wisconsin, even in California's own program. This is why Central Sands was able to cash in on over 9,000 offset credits during a period that it was dumping manure into local sources of groundwater.

The amount of regulatory power verifiers have to approve projects is also concerning because of the clear conflict of interests these groups have within their responsibilities as regulators. We can see this in verifier 2's discussion of the baseline that does not exist (personal communication 2022):

Like, I would say, like, I mean, we've done, you know, in the company history of like 15 years, we've done 1300-1500 audits, and like maybe 3 times we had one where we actually went to a site before the equipment was there destroying a greenhouse gas. It's very rare. So when you show up, everything is already there, so that hypothetical baseline of what was happening prior to the project doesn't actually exist. Do you understand? Like yeah there's no more release of methane from the lagoon because when I get there, the equipment is already there and it's already being destroyed.

The verifier and project developer are the main entities on the project that measure the baseline that all of the emissions reductions are compared to and this is part of the “magic math” that determines the value of these offset credits. However, not only are verifiers directly paid for their services by the project designer themselves, they work with the designer to make up a number where the baseline will be. This creates a large incentive for both the verifier and the developer to inflate the value of credits (which is called overcrediting) when those emissions reductions are not actually being met. It is particularly easy to do this on CAFOs because they are not required to monitor their emissions in the first place, so there is no way to confirm that these emissions reductions are happening on the ground. Overall, this undermines the legitimacy of these projects in the first place.

Q2- Who and what has driven/currently drives the research, development, and adoption of digesters on CAFOs as a “green technology” in the US and Wisconsin?

For Q2, I drew from critical agrarian studies and agrarian political economy (Goodman, Sorj, and Wilkensen 1987; McMichael 2005; Gillon 2016) as a way to situate the production of biogas on CAFOs within the larger history of agrifuel production (the creation of fuel from agricultural commodities) in the US. According to McMichael (2009: 26), the rise of agrifuels:

...follows a typical capital accumulation script – that is, attempting to overcome barriers to profitability by extending the realm of value creation, even as this intensifies capitalism’s contradictions ... The “agrofuels project” is central to this attempt to maintain profit, and to legitimize the state/capital nexus.

Throughout this dissertation I have defined neoliberalism as a crisis management strategy in addition to an ideology about the role of the state within the market (Centano 2012).

Substitutionism is one of those strategies. As highlighted by McMichael (2005), Gillon (2016), and Baines (2015), neoliberalism and substitutionism are very useful to use in conjunction

considering a key feature of neoliberalism is constant crisis, whether economic or ecological. Substitutionism, according to Gillon (2016), is one way to temporarily overcome the crises inherent to capitalism using technology as a means to create new commodities out of old ones or even commodities from *waste*. Digesters precisely fit here because they take a substance that dairy CAFOs already have too much of and turn it into a source of agrifuel. Technology is absolutely central to the very possibility of capital accumulation in these contexts.

Despite the prevailing notion that the private sector is the source of “innovation,” not the state, in the realm of agriculture, many advanced technologies used by the private sector today were either funded by the state or were developed within state funded universities (Slaughter and Rhodes 2004; Heisey et al. 2006). The coalition that emerged from this co-evolution I refer to as the state/science/industry nexus. The state/science/industry nexus of US agriculture describes the historical and contemporary interconnectedness of state knowledge producing institutions in the agricultural sciences and the private industries which have sought to use this knowledge to create, promote, and normalize technologies needed to surmount nature/labor barriers to capital accumulation within agriculture. Land-grant universities and Extension services were explicitly created by the state to foster the development of an agricultural industry in the US over a century before the emergence of neoliberalism. Within these spaces, there were already networks of actors within agricultural knowledge production whose goals gave a distinctive advantage to the largest and wealthiest agricultural producers. Neoliberalism has only increased the volume of these networks by introducing a litany of new markets, each with their own networks of state, scientific, and private sector actors.

For capitalists, green technologies have no value if there is no market for them. We can clearly see this in the case of ethanol, another type of “green” agrifuel (Carolan 2009; Baines

2015). Looking back to the case of ethanol, the industry experienced many booms and busts between the 1970s and today. Ethanol existed within its respective “technical niche” since the 19th century and during this point, it was ignored by the private sector. It was not until various fuel crises hit the US markets— first the 1970s fuel crisis and again during the early 2000s fuel crisis—that ethanol was pulled into the spotlight by the private sector and framed as an “energy solution.”

The first “wave” of ethanol production occurred during the 1970s fuel crisis. When the fuel crisis began, ADM, one of the largest corn and grain processors in the world, immediately began lobbying the state to provide generous concessions in order for them to build up a biofuel empire in the face of high fuel prices and declining profitability. Soon after, the National Corn Growers Association, the National Gasohol Lobby, and the newly established Renewable Fuels Association joined the chorus of voices praising the benefits of ethanol. These groups within the private sector representing the desires of corn producers used the state as a means to fund their build up of ethanol production and protect themselves from competition within the market by successfully lobbying for a 40-cent tax exemption on every gallon of ethanol that was combined with gasoline and a 40-cent tariff on every gallon of ethanol that was imported from Brazil. ADM was essential in pushing the federal government to establish policy early on that eventually benefitted ethanol producers later down the road.

The second “wave” of ethanol production in the early 2000s was also connected to a fuel crisis. However, the fuel crisis of the 2000s was only a partial driver of the biofuel boom. The market for ethanol exploded two decades later because of regulatory shifts made by the state between 1980 and 1990 as scientific evidence was becoming increasingly clear that leaded gasoline presented a clear public health threat and needed to be phased out (Johnson et al. 2021).

Between 1982-1995, the use of ethanol in the US remained relatively stagnant, particularly compared to methanol (specifically methyl tert-butyl or MTBE) which was the choice fuel additive for fossil fuel companies for several reasons. According to Johnson et al. (2021: 4):

Oil companies preferred MTBE over ethanol largely because it can be produced out of a combination of refinery byproducts and methanol, processed within the refinery complex, and put in a pipeline, thus being under the control of the refiner. In addition, MTBE used existing infrastructure. The use of MTBE increased rapidly between 1985 and 1999...

But within only 15 years, it became clear that MTBE was toxic for humans and the environment because it is far more likely than ethanol to leak into sources of groundwater. A central issue, much like in the case of CAFOs, was that the fuel industry was either unwilling or unable to fix storage tanks that repeatedly leaked MTBE into local groundwater sources across the US (ICIS 2006). California was the first state to ban MTBE in March 1999, citing concerns that it was “a significant risk to California’s environment,” (ICIS 2006; Johnson et al. 2021). MTBE had to be phased out in CA by the end of 2002. Four months later, the EPA completed their assessment of MTBE and recommended that its use should be seriously restricted in the US based on widespread evidence of groundwater contamination.

By 2002, MTBE was becoming politically untenable for the oil industry. With California banning the additive, the largest oil producers in the state, ExxonMobil and BP, agreed to phase it out between 2002-2003. Other producers, however, were hesitant to make the switch considering ethanol required substantial investments for companies compared to MTBE. Although some companies that served large markets in California made the choice to stop this practice, others were dragged kicking and screaming. In fact, throughout the entirety of 2004, the goal for the fossil fuel industry was to pass an energy bill with legal protections for the many lawsuits around polluted groundwater across the US. When it became clear that the federal

government would not include those protections as lawsuits were growing around the US, industry finally changed its tune and switched to ethanol just in time to profit off of it with the creation of the RFS program in 2005.

The central point of bringing in other biofuels was to show how the market and the private sector responds to social and environmental crises: they wait for the state. Despite the calls for marketization and the adoption of PPPs, just like in Q1, here we can see how reluctant the private sector is to meaningfully change their behavior to protect the environment and public health, yet the state has brought them in as a “partner” in regulation. Indeed, the same is true with the digester industry. Digesters do not require any meaningful shift in the consumption or production practices associated with massive CAFOs, but rather encourage the lock-in of existing CAFO infrastructure as it becomes intermeshed within markets for fuel. But as we can see above, the fossil fuel industry is regulated significantly more than agriculture. And here lies the central issue with digesters.

Throughout chapter 5, my theory of the nexus proved to be extremely useful during the process of tracing the development of digesters on CAFOs because the nexus could be observed in every case of early digester research. All of the pilot projects for digesters operated as partnerships between digester development companies, CAFO owners, and state agricultural knowledge producing institutions such as LGUs, Extension Services, and most importantly, AgSTAR. It was AgSTAR’s “charter farm” program that directly encouraged CAFO owners all over the US to use state funding and assistance to transform their farms into energy production facilities. During this research, I was also able to see the nexus *forming* by identifying “key players” and tracing how they bounced between roles within the private sector to the public sector. For example, Mark Moser was eventually hired by a private engineering firm that

constructed the first digester on a commercial dairy farm in 1979 (Lusk 1998). But before that, he was a student under Professor Bill Jewel who was the leader of a team of agricultural engineers at Cornell that created the third most common digester type used today (AgSTAR 2022d). From land-grant universities, Moser entered the private sector first as an engineering consultant, and then the head of his own digester engineering firm, RCM digesters, in 1982 which still exists to this day (Global Methane Initiative 2023). During the same period, Moser was very active in a number of projects for AgSTAR Charter Farms. He also was one of the authors of the second edition of the AgSTAR Handbook (2004).

Another example which blurred the lines between the public and private sector, and I was quite surprised to find, was Dr. L.M. Safley Jr. In the late 1980s, Safley Jr. and Lusk wrote reports together as agricultural engineers at NC State University where they worked on the first full scale covered lagoon digester (Safley and Lusk 1990). By the time the Lusk report was published in 1998, Dr. L.M. Safley Jr. was CEO of AgriWaste Industries (Lusk 1998). Indeed, AgriWaste was one of the project verifiers for Central Sands when they had thousands of carbon offset credits invalidated by ARB.

Despite the state funded build-up of manure digesters between the 1980s-2000s, industry was incredibly slow to adopt them because they were not only expensive, but there was no market for the electricity they produced. As I have noted throughout this dissertation, there are 2 million farms in the US and only 322 operational digesters on farms (USDA 2023; AgStar 2022b). The growth of digesters in the US can be largely attributed to various state market-based programs that paid farmers to generate electricity and fuel. One of the first of these programs in the US was in Wisconsin, Focus on Energy, which encouraged contract relationships between CAFOs and local utility companies for a generous price (Markham, Blaha, and Michalesko

2022). However, once these contracts were up and the price of electricity dropped, CAFO owners scrambled to find new uses for their digesters. Since 2020, many CAFOs in Wisconsin and all over the US have gradually switched out the CA's offset market and into another CA market: the low carbon fuel standard (LCFS). This program not only involves less environmental scrutiny for CAFOs in Wisconsin since they do not have to concern themselves with additionality, it also, up until recently, generates massive profits compared to the offset market. So much that market actors are framing it as "striking gold."

In tracing the history of digesters, the fact that CAFOs rely on the externalization of animal waste as a part of their production model was a key reason for the installation of digesters on CAFOs in the first place. Just like MTBE, CAFOs produce negative impacts related to air and groundwater pollution. This pollution often results in conflicts between CAFOs and the rural communities around them, but digesters were introduced as a way to quell those conflicts by reducing odors that stem from raw livestock waste sitting in open pits in the sun. As opposed to verifier 2 who framed the adopters of digester projects as inherently environmentally conscious, in tracing the evolution of digesters and the digester industry, I found that they were just as important to keep CAFOs operational when they could not control their odors and water pollution any other way and risked getting shut down by local lawsuits or state environmental agencies. This does not really indicate concern for the environment as much as it does with concern for having the farm shut down. In the words of Lusk (1998):

Moreover, without the environmental benefits provided by AD technology, some might have been forced out of livestock production. AD is sometimes the only technology that allows growth in the livestock production business. Turning a waste liability into a profit center that generates annual revenues can moderate the impacts of declining commodity prices and diversify farm income.

And they needed the state to do this.

Although there is a significant amount of knowledge we currently do not know about the impacts of digesters, the small body of existing research already indicates that there are serious issues happening on CAFO projects *now*. Going back to the definition of a “false solution” in chapter 1, one characteristic of false solutions is slightly altering a few aspects of the existing system, but not enough to result in enough GHG reductions necessary for change (Manure digesters hyperfocus on the removal of methane and ignore all of the other negative impacts caused by the CAFOs and the digesters themselves. The most concerning of these for climate change is nitrous oxide. According to the EPA (2023), “The impact of 1 pound of N₂O on warming the atmosphere is almost 300 times that of 1 pound of carbon dioxide.” On top of this immense warming capability, nitrous oxide stays in the atmosphere for 114 years, which is significantly longer than methane. Since 1990, nitrous oxide emissions have risen 40 percent in the agricultural sector Almost half (48 percent) of all GHG emissions within agriculture are from nitrous oxide and agriculture is already the largest source of this hyper-potent GHG in the US. In their study of the waste from digesters, digestate, Holly et al. (2017) found that over time, nitrous oxide emissions increased by 81 percent, resulting in an overall emission “tradeoff” between methane and nitrous oxide. Additionally, the “carbon accounting” of emissions within the process of manure digestion excludes N₂O from the baseline of every emission producing activity on the CAFO, even vehicle emissions (ARB 2014).

Other key aspects of false solutions include: 1) the creation of “net harm” by decreasing emissions but simultaneously increasing other pollutants that cause negative environmental impacts and 2) the imposition of costs and risks which are not fully understood onto actors with less political power. Aside from the methane reduction benefits, the second most important benefits of digesters for CAFO owners and operators are related to “odors” which I discussed

above. Again, the small number of studies that have been conducted on the impact of air pollution from digesters on rural communities presented troubling findings. When Zheng et al. (2019) studied the VOCs released from digestate during storage, they detected 49 different types of VOCs. The VOCs that caused odors represented only a small fraction of the VOCs present (5.15 percent of total VOCs), but non-odorous compounds that were hazardous to human health were still present. In fact, almost a third (32.77 percent) of the total VOCs emitted from digestate were hazardous to human health. Indeed, 8 of the compounds they discovered were carcinogenic and 14 were known to cause organ damage in humans. In other words, digesters do not eliminate odors, they simply transform them into something else: air pollution that is significantly more harmful for human health, but has less of an odor thus remains invisible. The implications of these toxic impacts for local communities remain understudied, yet these impacts are hardly mentioned by the EPA, USDA, AgSTAR, and other institutions within the nexus who have given unwavering support for these “green” technologies.

Section 7:2: Contributions and Limitations of the Dissertation

When I started this dissertation, I had no idea where it was going to go. But ultimately, what I have done throughout was interrogate issues that had bothered me for a long time. In doing so, I addressed a number of gaps that were relevant to my field of study. These contributions are both theoretical and empirical.

In terms of conceptual and theoretical contributions to the existing scholarly literature, the first contribution of the dissertation relates to the theorization of marketization within the neoliberalization of the state. In my major exam paper, I wrestled with the concept of marketization because of the lack of clarity in the literature within critical geography.

Specifically, scholars often conflate marketization with various terms including deregulation, privatization, commercialization, and corporatization in relation to state functions (Lerner 2003; Bakker 2007; Castree 2010; Loftus and Budds 2016). According to Bakker (2007), marketization describes the act of markets controlling how prices are determined and resources are allocated in her analysis of US fishery quotas. This is similar to Castree (2010) who defines marketization as, “rendering alienable and exchangeable things that might not previously have been subject to a market calculus,” (1728). To me, this seemed like a roundabout way of saying commodification, not marketization. Both Bakker and Castree claim that there is a distinction between marketization and the use of “market proxies” by the state, which describe the process of transforming the state into a market-like actor which prioritizes, “changes in resource management practices which introduce economic principles (such as efficiency), methods (such as cost-benefit analysis), and objectives (profit maximization),” (Bakker 2007; 103). However, they name this distinction commercialization, not marketization. Loftus and Budds (2016) make the same distinction, but discuss marketization as corporatization.

Drawing from Birch and Siemiatycki’s (2016) definition of marketization, I combined this definition with archival documents to work through how the EPA itself understood programs that have been identified as types of marketization, such as PPPs. PPPs are not only a common form of neoliberal governance, they are the primary way that the state has addressed environmental regulation since the 1980s and it is important to understand where these semi-privatized regulatory arrangements stand in relation to full privatization of state functions. During this research, I found a “spectrum” of privatization as understood by the EPA (EPA 1989). As opposed to Birch and Siemiatycki (2016) who explicitly frame PPPs in the context of marketization, the EPA views both privatization and marketization (such as contract services) as

forms of public/private partnerships. However, the theoretical distinction between them is still intact: privatization involves less state and more private involvement than marketization. These theoretical distinctions are very important in the analysis of the neoliberalization of state functions.

The second key theoretical contribution of this dissertation is the theorization of the state/science/industry nexus within US agriculture. In searching for my committee for the dissertation, I had reached out to an agricultural economist that studied issues around CAFOs and water pollution. The first thing they said to me was that the pollution concerns in rural communities were vastly overblown. To hear someone who apparently studied these issues talk about the communities in such a negative way was shocking. But the more I looked, the more I realized this perspective within the agricultural sciences was not unique. To bring in John Ikerd, a former agricultural economist and head of the department of agriculture at an LGU for decades (2009: 1):

For decades, CAFO proponents have demanded that any regulation of CAFOs be based on “sound science,” while labeling CAFO opponents emotional and uninformed. They have pointed to the support of the USDA, state departments of agriculture, and the agricultural universities as clear and compelling evidence that science had validated the legitimacy of CAFOs. They dismissed the persistent opposition of people as the irrational fears of people who have been misinformed by environmental extremists, even though opposition emerges in virtually every community where CAFOs attempt to locate. To the contrary, the legitimacy of public concerns about CAFOs is instead confirmed by the predominance of scientific evidence...The emerging scientific consensus of public health research is that CAFOs represent a significant risk to the environment and public health. The predominant scientific opinion of social science research is that negative social impacts of CAFOs more than offset any potential economic benefits.

This reflects a very important element of this dissertation: CAFOs are becoming increasingly contested not only on the basis of public health impacts, but because of their contributions towards climate change. It was this quote that got me interested in understanding the agricultural

sciences as a very unique scientific space because the institutions at the center of the “agricultural establishment,” as termed by Ikerd (2009), existed before neoliberalization. However, in my theorization, I expanded this by adding the element of industry, particularly considering the relevance of marketization and privatization of the state with the emergence of neoliberalism. Industry needs to have a place within this nexus because, as I have noted before, at various points in my research it was nearly impossible to tell which actors were located in the public sector or the private sector. These connections are so deep that there is immense theoretical value in grouping them together to see how it influences environmental policy over time as the pressure heats up to find “solutions” to the private sector’s emissions problem.

The final contribution of this dissertation is to situate CAFOs as a new source of agrifuel in the US. Specifically, I extend the theory of substitutionism from biofuels such as ethanol to biogas. CAFOs are already a major source of air and water pollution in the US. By integrating into the fuel system, biogas and digesters provide a useful way to “green” a very dirty form of fuel production. This has serious implications for the environment and rural communities, yet, as I discuss in the next section, they have already been framed as a win-win by the state/science/industry nexus.

Several empirical contributions are also offered by this dissertation. The first is an analysis of anaerobic digesters on CAFOs rooted in political economy, environmental sociology, and critical agrarian studies. The literature within sociology, political economy, political ecology, and even critical waste studies has yet to analyze the practice let alone the history of their development. The scholarly literature on digesters remains deep within specialized journals in chemical, biological, and agricultural engineering, soil science, microbiology, energy studies, and animal science (Awasthi et al. 2019; Waldrip et al. 2019; Li et al. 2018; Wukovits and

Schnitzhofer 2009). There were some sources in environmental law (Camillo 2013; Lazenby 2022), but outside of these sources, the material referencing digesters within the social sciences is quite limited.

Another empirical contribution is the timeline of digester research and development. The Lusk (1998) report was useful for understanding the early years of development, but it was after this point that digesters started growing on CAFOs. By the time the Lusk report was released in 1998, there were only 28 digesters on CAFOs in the US. By the spring of 2000, the number had increased only slightly to 31 projects, but at this point, AgSTAR had successfully established 13 different projects across the country just as the charter farm program ended in the fall of 1999, meaning almost half of all of the farms with digesters emerged with the assistance of AgSTAR (AgSTAR 2000). Aside from the coverage from BioCycle, which was nowhere as detailed as the information in AgSTAR archives, there was limited coverage of the R&D and adoption of digesters between 2000-2006. It was during this time that Wisconsin surged in the number of digesters on CAFOs, more so than any other state including California. It was not until 2019 that California finally surpassed Wisconsin, in large part due to the LCFS program.

The final empirical contribution of this dissertation is the focus on the state-level conflicts that arise when programs from one state (CA) operate in another (WI) with vastly different, and weaker regulations than the first. The neoliberal, marketized programs within the state of California over the past decade have enabled, and ultimately driven with the LCFS program, deregulated CAFOs in the state of Wisconsin to collect immense amounts of money as they claim they are part of the solution to the climate crisis, not the problem. The case study of Central Sands including the interviews with regulators and verifiers can provide other researchers with detailed insights into a case of invalidation outside of ARB's reports.

Still, this dissertation does have limitations. Although the interviews I did have were extremely insightful, there remains a gap in my research because I could not get access to many different groups that operate within CA's carbon markets. ARB, at the time, did not respond to my interview requests and neither did project developers. Since project developers are absolutely central to the daily operations of digester projects and they were very involved in the process of invalidation, this is a huge limitation not only in terms of understanding the role of a developer, but their role as market actor/regulator. In a similar vein, the small number of verifiers interviewed for this project is also a limitation.

Section 7.3: Directions for Future Research: Tracing the Contemporary Lock-in of Manure

Digesters within the US

Throughout this dissertation, I described LCFS as a central driver of digester growth over the past 5 years. Indeed, in California, 79 percent of their digesters were installed after 2018 (AgStar 2022b). This surge in digester adoption related to LCFS is connected to a theme that became apparent during comparative historical analysis: the importance of economic “booms and busts” for the digester industry. Historically, and also in the case of LCFS, these cycles were largely driven by macroeconomic conditions related to fuel crises. As I noted in chapter 4, the invasion of Ukraine in 2020 resulted in a sharp increase in global fuel prices (Koeze and Krauss 2022). This, in turn, raised the cost of everything else in our fossil fuel dependent agricultural system. When adjusted for inflation, by 2022, fuel prices were at their highest since 2014. But since then, fuel prices have leveled out and the “gold” LCFS market has started to cool.

Despite decades of R&D by AgSTAR and the private sector, they have not been able to reduce the cost of digesters sufficiently. This was highlighted in the most recent report by Aaron

Smith, a professor of agricultural economics at UC Davis (Smith 2023). Currently, digesters cost 10 times more than the RNG they produce (Smith 2023). According to Smith (2023):

From mid 2018 through 2021, revenue from digesters was approximately twice as large as costs, mostly due to the LCFS. Those were good times to be in that business. The price of LCFS credits has declined as the market has become awash with renewable diesel, so new digester projects are currently much closer to the break even point.

The nexus, however, has already concluded that the “potential” for digester technologies far outweigh any other solutions. ““What’s the alternative?” said Bob Powell, chief executive of San Francisco-based digester developer Brightmark LLC. ‘More methane into the air.’” (Douglas and Groom 2022).

However, the gold rush is not over. The California Department of Food and Agriculture, which is just one of many state agencies in CA, has set aside \$48 million for dairy digester research and development for 2023 alone (California Department of Food and Agriculture 2023). The Inflation Reduction Act (IRA) passed by Congress and the Biden Administration in 2022 created more programs to fund the build up of digesters all over the US (Levin 2023). First, the IRA goes beyond the historical level of tax credits for projects that the state was willing to fund— from 30 percent to 50 percent. This would be on top of the \$100 billion set aside to support state-level project development and the \$27 billion “green bank” already set aside to fund projects with digesters. Lastly, and most concerning for the build-up of digester projects in the US, the IRA makes many of these tax credits *permanent*. As negotiations for the 2023 Farm Bill move forward, where there is potential for the creation of even more funding, research, and development.

Indeed, currently, we have arrived at a critical juncture for digester growth in the US. Looking back to MTBE, since it was so widespread, it took less than 20 years for regulators to

realize that the environmental consequences were so severe. Unlike MTBE, over the last 40 years, digesters on CAFOs have been relatively rare. But because they are so rare, there are serious limitations to the research that currently exists regarding the negative social and environmental impacts of digester technologies. This was recently highlighted by Senators Booker, Gillibrand, Sanders, Warren, Markey (2022) in response to the federal government's continued reliance on methane digesters to reduce greenhouse gas emissions and create green fuel. According to the statement:

To our knowledge, USDA has not yet produced evidence that subsidizing manure digesters will reduce absolute emissions from the agriculture sector, which is the top source of U.S. methane emissions...Additionally, we remain concerned that USDA has not fully explored or produced evidence of the impacts of manure methane digesters on other key issues. These issues include co-pollutants of Concentrated Animal Feeding Operations (CAFOs), food system concentration, public health, and heightened community risks for rural, low-income, agricultural-dependent, and Black and Brown communities.

Now is the time to critically evaluate CAFOs as a source of electricity and fuel as they are poised to expand further throughout rural communities which are already experiencing environmental injustices across the US.

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Vita

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