Thirty States of Renewability: Controversial energies and the politics of incumbent industry

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Abstract

Renewable energy advocates have positioned a wide array of technologically novel energy sources as fossil fuel alternatives. These efforts to usher in renewable energy transitions have long been shaped by definitional contestations. Political ecological scholarship tells us that such definitions are meaningful. Indeed, labeling energy sources as renewable has become a power-laden act, which may spark innovation, yet simultaneously create openings for problematic classifications and unjust socio-ecological relations. However, we still know too little about how such classification politics are taking shape within green industrial policy formation; particularly, how they encounter incumbent industries and industrial regions. In this paper, we argue that these theoretical questions are crucial for an emerging industrial political ecology, and explore three recent developments in the US context. A country that has notoriously avoided open and coordinated national industrial policy, the United States has approached the renewable energy economy in a similarly geographically-fragmented fashion. We highlight a central yet under-examined tool in US energy-industrial policy: the renewable portfolio standard (RPS). Mandated by thirty states, RPSs are the US's central mechanism for renewable energy procurement—yet RPSs diverge substantially from state to state in terms of the energy sources they classify and incentivize as renewable. We argue that industrial interests and state governments have together capitalized upon RPSs' malleability to support regionally significant sectors, including "dirty" industries and industrial wastes. These industries, often controversially, thereby position themselves for rebranding and new forms of value capture.

Highlights

1. US state governments are supporting regionally significant, yet controversial incumbent industrial sectors through Renewable Portfolio Standard policies.

2. Regionally significant industries are engaging in processes of rebranding and new value capture in response to opportunities and threats posed by climate change.

3. US Renewable Portfolio Standards are sites of definitional struggles over classifications of renewable energy sources, including novel waste-to-energy proposals.

4. Industrial political ecology provides important insights into the transformative possibilities and dangers, from greenwashing to environmental injustice, of controversial renewables.

Keywords: renewable energy transitions, US Renewable Portfolio Standards, politics of classification, industrial political ecology

Introduction

From renewable energy's early days in the 1970s Energy Crisis to its ongoing boom today, novelty has lent a significant technological and definitional openness to the sector. Multiple generation sources contribute to renewable energy portfolios (Hirsh, 2001). Political ecological scholarship increasingly tells us that labels like "renewable" hold meaning (Behrsin, 2019b). Indeed, classifying energy resources as renewable has become a politically significant act, creating openings for problematic classifications and unjust socio-ecological relations. Attention to definitional battles around renewables joins a wave of recent political ecology research on renewables highlighting how uncritical equation of renewables with environmental benefits and justice can facilitate perverse outcomes (Levenda et al., 2021). For example, political ecologists have particularly noted the land-extensive nature of many rising renewable energy forms (Huber and McCarthy, 2017), and warned of new "green" land grabbing (Fairhead et al., 2012), social marginalization (Baka, 2014), and ecological harm (Mulvaney, 2019).

Yet as Bridge (2018) has recently argued, social-scientific energy research's preoccupation with rising energy technologies has obscured an equally crucial face of today's energy transition: the question of incumbent industry, and in particular its strategies and future in a prospective renewable energy economy. Existing analyses of incumbency frequently focus on the compelled or (dubiously) self-managed "disassembly" (Bridge, 2018) of emissions-intensive industries and infrastructures facing "transition risk" (Christophers, 2017), from fossil fuels to other carbon-intensive sectors such as heavy industry and food production (Bridge and Gailing, 2020; Knuth, 2017). Others underline the power that incumbent fossil fuel industries maintain to resist and delay energy transition in the United States (Stokes, 2020) and other legacy production regions (Kuchler and Bridge, 2018).

In this paper, we emphasize another strategy: incumbent-industrial bids to *use* the renewable energy economy to capture new forms of value and/or as an opportunity for rebranding. These attempts frequently provoke charges of industry "greenwashing"—and may well deserve the critique. Nonetheless, we argue that they require deeper scrutiny within analyses of renewable energy transition. Though trends like new fossil fuel sector investment in mainstream renewables (e.g., offshore wind projects) demand investigation, we highlight another face of these efforts: incumbent industries' power to *redefine* other energy sources—to "render [them] renewable" (Behrsin, 2019b)—in their favor. Such efforts underline the politics of renewable energy classification, and how incumbent industries may shape them and their power within complex, regional trajectories of novelty, obduracy, and path-dependence. Particularly, we consider here three industrial waste byproducts that have been classified and incentivized as renewable energy resources within recent US energy-industrial policy, and the significance of these classifications for the differentiated array of "dirty", carbon-intensive[1] incumbent industries that generate them. Through this exploration, we address an important gap in existing scholarship: we still know too little about how renewable energy's classification politics are taking shape within green

[1] Adopting a common shorthand, though methane and nitrous oxide are more significant greenhouse gases than carbon dioxide for some processes considered here.

industrial policy formation; particularly, these thorny questions of how they encounter incumbent industries and industrial regions.

The United States (US) has approached the renewable energy economy much as it has national industrial policy: in a geographically fragmented, piecemeal fashion. In place of coordinated national policy, US states have instead led the country's renewable energy transition (Rabe, 2006). This paper examines the role of incumbent industry in shaping renewable portfolio standards (RPSs), central yet under-examined tools in state energy-industrial policy. RPS policies require certain electricity providers to provision specified amounts of renewable energy over a particular period of time. Used as binding policies by thirty US states, RPSs are a central mechanism for the country's renewable energy procurement (Barbose, 2019). Crucially, RPSs also stipulate, with considerable freedom, what *types* of energy resources are eligible as "renewable." We argue that US state governments are supporting regionally significant, yet controversial incumbent industrial sectors through RPS policies' classificatory malleability. We briefly illustrate our analytical argument via three recent "waste-to-energy" cases: in Pennsylvania (waste coal from mining), Oregon (biomass waste from logging and industrial forestry), and North Carolina (animal waste from industrial-scale livestock). Each case highlights projects to redefine and revalue waste byproducts by focusing on how classifications of, and incentivization structures for, renewable energy resources have been conditioned by industries with particularly strong footholds in the states in which they are based.

Analytically, we highlight the usefulness of an emerging "industrial" political ecology (Huber, 2017). We suggest that the subfield may usefully look to political ecology's long history with/in geographical political economy for important tools for regional industrial and industrial-political analysis. Moreover, taking industrial incumbency seriously is crucial to industrial political ecological work on a just transition given the multi-sided costs of both deindustrialization and redevelopment. In discussing the cases surveyed here, we will argue that this combined inheritance gives industrial political ecology important analytics for diagnosing greenwashing and forms of environmental destruction and injustice emerging within or perpetuated by incumbents' (re)definitional projects. Frequently, these amplify deeper injustices of racial capitalism. We also suggest that projects of redefining/revaluing industrial wastes and "dirty" sectors may offer important windows into more elusive, if never guaranteed, possibilities of genuine techno-organizational redefinition, qualitatively novel forms of value capture within existing industries, and reassembly.

Theorizing an Industrial Political Ecology of Renewable Energy

The Industrial Politics of Energy Transition: How Do Incumbents Face Renewables?

Notwithstanding political ecology's aforementioned inroads into critiquing renewables as a driver of land contestation, we argue that fully taking on renewable energy in its diverse realizations—including how it might and might not be classified as environmentally beneficial or just—requires asking additional *kinds* of questions, and engaging the field's more plural traditions. Notably, political ecology requires more sustained engagement with renewable energy industries *as* industries that take shape in and through familiar industrial-geographical dynamics and prompt durable environmental degradation and (in)justice questions: on the factory floor, in waste byproducts and environmental harms, and within globalized supply chains and extractive geographies of materials sourcing. In this intervention, we echo Baka and Vaishnava (Forthcoming), and particularly Mulvaney (2014, 2019) and Bridge and Gailing (2020). More broadly, we join other recent arguments for "industrializing" political ecology (Barca and Bridge, 2015; Huber, 2017; Newell et al., 2017). Though these calls root themselves in distinct scholarly conversations and propose non-identical programs of research, we suggest that all are useful in illuminating under-examined questions in the renewable energy economy. Departing somewhat from their takes, we simultaneously underline political ecology's *existing* toolkit for interrogating industrial processes, an inheritance of its longer legacies with/in geographic political economy (McCarthy, 2012). We suggest that this combined tradition gives us many tools for scrutinizing industrial formations, including renewables, particularly in their regional(-political) embeddedness.

We apply these tools to a largely unconsidered facet of renewables development today: the entrance of a range of firms and industrial sectors frequently considered "dirty" and environmentally controversial into the renewable energy space. Bridge (2018, page 17, emphasis added) has recently argued that "to an extraordinary degree…[social scientific work on energy transition] has focussed on *innovation* and the diffusion of *new* socio-technical configurations over time and space." He maintains that this preoccupation with technological novelty and emergence has meant a problematic under-attention to questions of incumbency. Incumbent strategies, he argues, may take many forms. Bridge considers how such sectors might resist the potential destabilization of structural shifts to renewables and a low-carbon economy via either 'last-gasp' incumbent innovation or "defensive political moves to limit or resist further systemic change" (p. 18). This picture of interest group lobbying to resist outright and politically exclude a broad class of technological rivals is realized in Stokes' (2020) picture of US fossil fuel industries' "organized combat" against renewable energy challengers, often waged through RPS standard-setting and rollback processes. Kuchler and Bridge (2018) present another facet of this political resistance in policymakers' efforts to rehabilitate socio-technical imaginaries of coal and coal's future in Poland.

However, we suggest that the suite of strategic responses that scholars like Bridge (2018) raise as possibilities for incumbent industries facing energy transition remains somewhat restrictive. We maintain that these moves, while undoubtedly important, fail to encompass the full range of strategies that "dirty" incumbent industries and/or supportive political institutions are currently deploying in response to the rise of renewable energy as a sector. The mobilizations around incumbent industries that we explore in this article's three cases are more challenging to interpret (particularly in real time), and we will argue they do not fit comfortably within either of Bridge's categories. This is perhaps particularly true because we examine several industries that are new entrants into the modern renewable energy sector: timber and livestock agro-industry. Both industries are, like coal, carbon-intensive and embattled on other environmental questions, including racialized environmental injustice. Despite these critiques, these incumbents have couched their entry into renewable energy generation in terms of endogenous technological novelty and fresh value capture opportunities: an ability to generate solutions from within, including from unlikely sources such as industrial waste streams.

Waste to Renewable Energy Source? The Politics of (Re)Classification

In advancing a more expansive and hybrid lens into incumbent-industrial relations with/in the emerging renewable energy economy, we build particularly on recent scholarship that questions the role of knowledge claims in constituting and incentivizing contested energy resources as renewable (Behrsin, 2019b, 2019a; Palmer, 2020). Previously examined energy resources include municipal solid waste included as part of European biomass schemes (Behrsin, 2019b) and in Maryland's RPS (Behrsin, 2019a), as well as forest biomass pellets being produced by the US Southern timber industry and exported for European electricity generation (Palmer, 2020; see also Carton, 2016). In a different mode, Knuth (2019) explores how energy efficiency retrofitting practices reclassify and revalue energy "waste" in degraded buildings, and increasingly harness such reclassifications to growing real estate asset values.

This research presented here identifies additional controversial energy resources and dirty parent industries now being "rendered renewable" (Behrsin, 2019b), and the processes through which such classifications are constructed and put to work. It advances a broader critical scholarship questioning how waste in various forms is made valuable/rendered a resource(Gidwani and Reddy, 2011; Knapp, 2016; Moore, 2008). Much geographic literature on waste focuses on global commodity chains and global production networks to illustrate how value is produced via material capture, material processing (both taking things apart and putting them together), and the distribution and sale of various materials derived from wastes (Gregson and Crang, 2010; Lepawsky and Billah, 2011). Schinlder and Demaria (2019, page 9) argue that this search for surplus value constructs waste as a commodity frontier where

> various modes of valorization grant opportunities for value to be created (i.e. through labor), enhanced (i.e. through a new technology, method or organizational structure) and captured by powerful strategically-situated actors.

They also note important political ecological effects of different modes of valorization: in their concept of a socio-metabolic reconfiguration*,* competition and reconfiguration of actors "often results in ecological distribution conflicts over value creation, enhancement and capture" (2019, page 6). Millington and Lawhon (2019, page 1054) contribute that the contingency of supply chains and the materialities of waste are central to the creation of value (or not), as "many waste materials...have very little economic value unless conditions can be *rendered right*" (emphasis added). For waste to attain capitalist value, then, requires a particular set of conditions that do not exist apriori, but are (re)assembled in projects of accumulation. Among these conditions, we argue, are the intersecting energy classification schemes in which materials deemed "wastes" are embedded.

These contributions point to the essentially political nature of the classifications examined in this article. Our exploration advances political ecology's broader questioning of classification, measurement, and how such processes characterize the state's role in resource-making (Bridge, 2014; Robertson and Wainwright, 2013). As Cooper (2015) has argued, this "metrological" theorizing has often centralized tools like standards and processes such as valuation, commodification, and commensuration necessary for making novel markets, but its analytical purchase does not end there. Indeed, existing research on the intersection of waste and renewables classification has begun to scrutinize energy policy instruments as power-laden sites for both market-making, as in the case of the European Union Renewable Energy Directive's treatment of waste incineration (Behrsin, 2019b), and broader redefinitional projects: for example, waste's shifting representations as dirty environmental justice villain, climate solution, and commodity as reflected in Maryland's Renewable Portfolio Standard (Behrsin, 2019a) and the European Union (Behrsin and De Rosa, 2020). As we consider other examples, we draw on under-utilized contributions from critical industrial geography that examine how industrial wastes have been recaptured to generate qualitatively novel products and sectors (Romero, 2015, 2016; Walker, 2016).

Important insights also come from redefinitional politics of energy envisioned through racial justice movements (Lennon, 2017), amid broader critiques of the definitional exclusions necessary to the reproduction of racial capitalism (Melamed, 2015; Pulido, 2016b, 2016a)—including its imagined 'low-carbon' futures (Bigger and Millington, 2020). Of particular importance is the growing understanding of the failure of the state to deliver environmental justice through regulation or other mechanisms of accountability (Pellow, 2016; Pulido et al., 2016). In the context of just transition activism and policy, we are likely to see more environmental justice activists engage in strategies beyond or against the state, especially as struggles for energy transition are more deeply connected to racial justice and Indigenous resistance (Estes, 2019; Gilio-Whitaker, 2019). Struggles over rendering energy sources renewable in state RPSs are thus less likely to embody EJ principles unless significant pressure is placed on legislators, who are often tied directly to industry through campaign contributions and lobbying (Stokes, 2020).

Industrial Policy for Renewables? Regionalizing Incumbency

Finally, there is still little research that addresses how renewables (re)classification politics are taking shape within broader industrial policy formation, and its differentiated geographies. Tackling this question is particularly imperative as renewable energy becomes a central target for developmental state policies and programs, economic stimulus packages, and other industrial politics (e.g. Mulvaney, 2019; Spivey, 2020). As Bridge and Gailing (2020) have compellingly argued, "pathways to decarbonization are conditioned by existing geographies (in relation to legacies of investment in infrastructure, for example)," and state programs and policies increasingly select energy sources/technologies that advance other regional economic goals such as securing technological rents (Knuth, 2018). However, we need to know more about what specific instruments are being enlisted in, or created for, these emerging green industrial policies. We argue here that tools like RPSs, historically framed in terms of advancing governmental energy and climate commitments, are increasingly functioning *as* industrial policy. As Stokes (2020) similarly argues, US state-level RPSs prospectively create prospective forms of path-dependence for novel technologies and industries, though also delineate political terrain for incumbents to target, in her analysis framed chiefly in terms of combat rather than the more ambiguous (re)definitional efforts considered here.

The regional scaling and potential regional particularism of state-level RPSs as industrial policy speak to important theoretical traditions within political economy and economic geography. While scholars have certainly questioned national industrial policies, both official and 'hidden' (Block and Keller, 2011; Mazzucato, 2015) the industrial region has formed a central unit of geographic analysis (Massey, 1995; Pike, 2020; Storper and Walker, 1989; and see Bridge and

Gailing, 2020). This body of research covers diverse strategies and policy mechanisms through which regional governments have both fostered industrial agglomerations, regional value capture/rents, and distinctive trajectories of techno-organizational development, as well as been shaped themselves institutionally in the process. Here again, however, we encounter similar preoccupations with novelty as Bridge (2018) critiques: in centralizing the imperative to develop a more critical and relational industrial location theory, analytics such as ‘geographic industrialization’ (Storper and Walker, 1989) likewise privilege *new* sectors and/in the emergence of industrial regions.

To locate relevant precedents for analyzing diverse incumbent industries and industrial regions, and how their firms and embedded political institutions are responding to the potential structural shift of a low-carbon economy, we must look equally to political economic scholarship on long-term continuity and change in industrial regions (Massey, 1995). Geographical political economy continues to debate regional futures of deindustrialization and prospective reinvention; as Pike (2020, page 2) argues, “torn between the seemingly irreversible structural shifts in economies suggested by Hall’s (1985) interpretation that ‘tomorrow’s industries are not going to be born in yesterday’s regions’ and Krugman’s (2005, p. 1) more optimistic identification of the potential for ‘second winds for industrial regions’.” In the United States, regions have chronically built deeply racialized injustice into such projects of industrial redevelopment and novel value capture—underlining the potential for such “reinventions” to work in more fundamentally regressive ways (e.g. Gilmore, 2007).

We suggest that the combined industrial political ecological framework we develop here—articulating analysis of dovetailed renewable energy and waste (re)classification projects with more situated insights from geographical political economy—can help us better understand how incumbent industries and regions are facing the green industrial economy. This coupled approach can unearth forces that motivate industries and regional policy-makers to claim waste as a renewable energy resource and new source of value, as well as highlight the diverse advantages that state-supported labels and legitimation may convey: new market opportunities, state funding, regulatory support, environmental review expediency, and beyond. US RPSs, discussed in the following section, are policy instruments that proffer many of these opportunities.

US Renewable Portfolio Standards: From Energy to Industrial Policy

Though the United States subsidizes the development of a range of renewable energy forms at the federal level, RPSs are the country’s central governmental mechanism for renewable energy *procurement*. As with much else in US federalism, state governments have led the way in setting these more directive policies; the United States has no unified national mandate. State RPS policies require electricity providers such as investor-owned utilities to provide specified amounts of electricity from governmentally-determined renewable energy sources over a particular period of time. Thirty states, plus the District of Columbia, have at the time of writing passed mandatory RPS requirements; an additional seven have less-stringent renewable energy ‘goals’ (Bandyk, 2020; DSIRE, 2016). US national lab analysis suggests that approximately half of the country’s growth in renewable energy generation and capacity since 2000 can be attributed directly to state-level RPS requirements (Barbose, 2019).

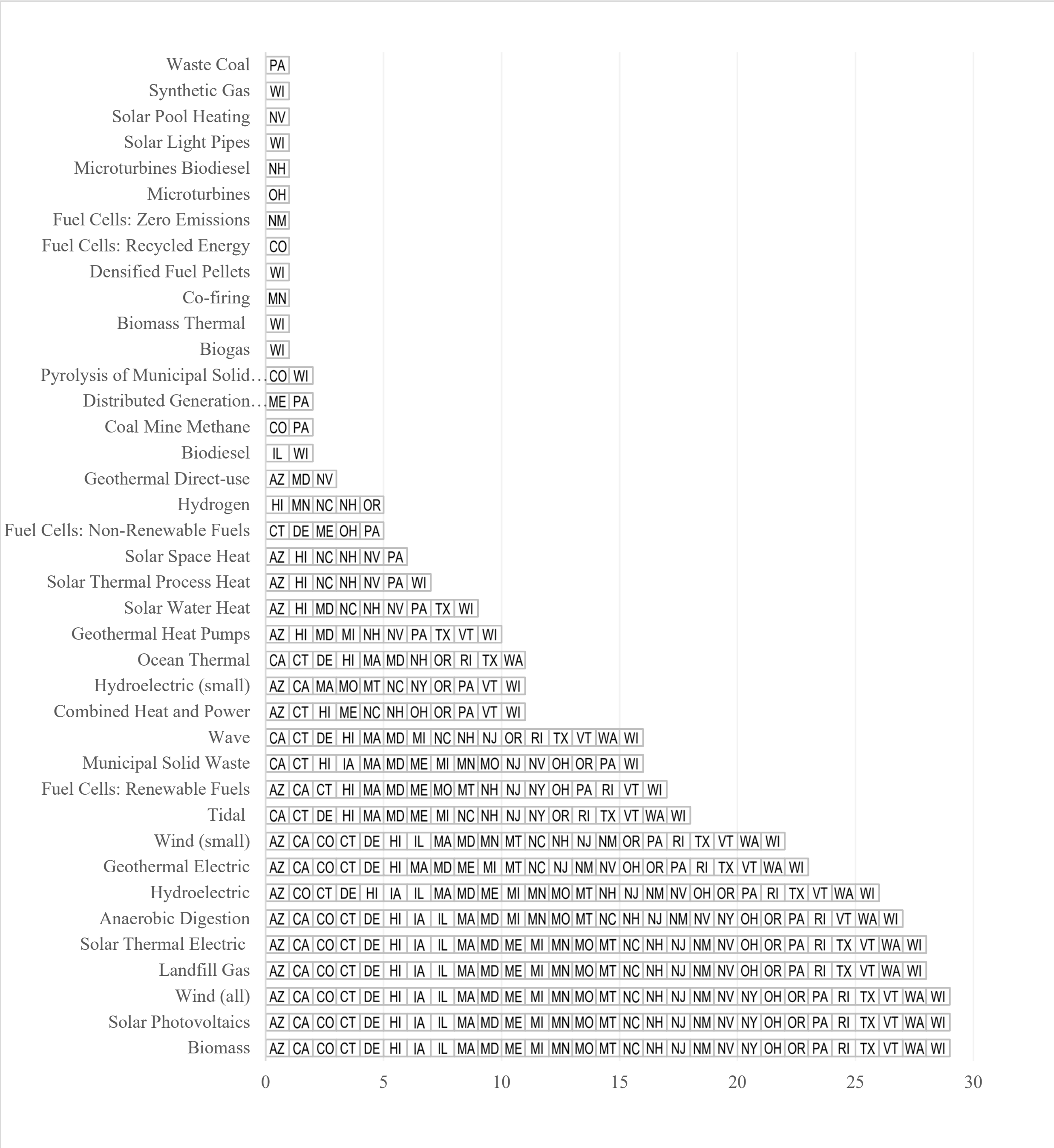
Iowa was the first state to adopt this type of policy, doing so in 1983, in the immediate wake of the 1970s Energy Crisis. Officially termed an "alternate energy production requirement," Iowa's RPS policy reflected the state's identification of economic development opportunities when energy demand and the cost of constructing new traditional energy facilities were high (Carley and Miller, 2012, page 732; Lyon and Yin, 2010). The bulk of new RPS policies were implemented between 2000 and 2009, when nineteen states enacted them (Barbose, 2019). Virginia, which passed a non-binding renewable energy policy in 2007, became in April 2020 the most recent state to adopt a RPS requirement (Bandyk, 2020; Mercure, 2020). However, because RPSs are implemented by individual states, they vary widely —for example, in what they are termed. Research institutes and organizations that have conducted in-depth, longitudinal research on RPSs (e.g. the North Carolina Clean Energy Technology Center's Database of State Incentives for Renewables & Efficiency (DSIRE) and the Lawrence Berkeley National Laboratory's Electricity Markets and Policy Group) collectively label the policies RPSs. However, the policies examined in this article, for example, are named by their respective states: Alternative Energy Portfolio Standard (Pennsylvania Public Utility Commission, 2017), Renewable Portfolio Standard (Oregon Department of Energy), and Renewable Energy and Energy Efficiency Portfolio Standard (North Carolina Utilities Commission).

Significant axes along which RPS policies vary include geographic sourcing requirements (the extent to which renewable energy must be generated in-state), and exemptions for particular types of energy producers (Carley and Miller, 2012). In addition, there is great variation in the types of sources that states classify as eligible for meeting RPS requirements [See Figure 1]. Berry and Jaccard (2001, page 265) argue that the variation among states in terms of eligible sources depends "in part upon the objectives of the RPS and the local viability of different types of resources." Building on this argument, we suggest that RPSs are being tailored to advance region-specific political economic and industrial interests. RPS policy designs also differ in that some incentivize particular energy sources. A 'tiered' RPS, for example, groups fuel types by priority, and assigns a percentage obligation for each tier. Essentially, a first tier grouping would incentivize more desirable resource types (often solar and wind), and lower tiers would contain less desirable fuel types (Forte et al., 2017). Some states also employ a 'carve-out', or 'set-aside' strategy to encourage particular energy sectors. These procurement sub-mandates require a certain percentage of the RPS target to be met through specified energy sources. Gaul and Carley (2012) argue that carve-outs are intended to attract investors to specific industries in particular states, and to create favorable market conditions for these industries. Yet, again, the specific energy sources prioritized in these incentives vary from state to state.

The purpose(s) of RPS policies have largely been articulated in terms of furthering states' climate and environmental commitments, or as an energy security policy to cushion state energy systems against fossil fuel price volatility (Berry and Jaccard, 2001; Carley and Miller, 2012). However, state governments have also long envisioned RPSs as potential economic development policies, as Iowa's early example suggests. Rabe (2004, 2006) argues that many RPS policies discursively emphasize economic benefits, sometimes over environmental ones. Similarly, Stokes (2020) argues that RPSs are sometimes enacted specifically to germinate industrial strongholds in their states. More particular economic development advantages touted in RPS policies include job creation, direct investment from facility construction and operation, tax revenues, indirect and induced economic impacts that result from the purchase of goods and services (Barbose et al., 2015), and new opportunities for local technological expertise to take hold (Berry and Jaccard, 2001). Indeed, Jones et al. (2015, page 3) suggest that California's RPS, initially passed in 2002, had by the mid-2010s generated 130,00 direct and indirect jobs; they project that raising the standard to 50% by 2030 would create a total of 879,000 to 1,067,000 jobs.

As renewable energy resources and technologies become central targets for industrial policy, RPSs' economic power is increasingly significant, practically and analytically. Because the United States lacks a unified national energy policy, US states have been for all intents and purposes leading green industrial policy formation. We must therefore question the distinctive attributes and potential significance of this regionalism. We suggest that RPSs have acquired a particular power in the US's decentralized and uneven setting, which may in a more sympathetic light be interpreted as a conducive environment for regional experiments in climate and green industrial governance—what Bulkeley and Castán Broto (2013) call, after Louis Brandeis, 'laboratories of democracy'. Notably, RPSs provide state-level policymakers a flexible site for individuating particular renewable energy forms, unevenly incentivizing them, and imposing specific conditionalities in their provision.

Figure 1 - Eligible Fuel Sources in US state RPSs [Source: DSIRE][2]



[2] n.b. This data is through October 2019. It therefore does not include the technologies included in the Virginia RPS, which was passed in April 2020.

Uses or Abuses of RPS Classification? Three Controversial Renewables Cases

A set of brief cases highlights a more particular economic power of state RPSs, specifically how their capacity to classify and incentivize renewable energy forms may be sculpted to benefit incumbent regional industries. Though this lens might turn up many examples that warrant scholarly attention, again we focus here on notably controversial renewable energies and parent industries. The vignettes outline the specific environmental and industrial histories of regions in which these contested energy resources have emerged, and the institutions and political actors that drive their renewable classification. Two cases, Pennsylvania and North Carolina, scrutinize renewable energy resources that are rare among state RPS policies, the former RPS in its resource inclusion (waste coal) and the latter via an unusual set-aside incentive (for animal waste). The Oregon case suggests that biomass, included to some extent in all thirty state RPSs (Figure 1), has been more particularly made meaningful and incentivized in conjunction with the refashioning of Oregon's timber industry.

Coal Waste in Pennsylvania's Alternative Energy Portfolio Standard

Pennsylvania's RPS (Pennsylvania Act 213 of 2004) was signed into legislation by then-Governor Ed Rendell. While it resembles other states' policies in many ways, Act 213 is unique among state RPSs in that it includes waste coal as an eligible fuel source. With Colorado, it is one of only two states to explicitly include a coal-based fuel in its RPS (DSIRE, 2015, 2018). Pennsylvania's RPS stipulates an 18% alternative energy target by the year 2021, which the state is set to meet (McDevitt, 2020). It is structured around two tiers, as well as a 0.5% carve-out for solar photovoltaics. Methane from abandoned coal mines is classified as a tier I renewable, whereas coal waste is classified as a tier II fuel.

Pennsylvania is the country's third largest coal producer, behind only Wyoming and West Virginia. In 2018, the state's 151 mines produced nearly 50 million short tons of coal, both bituminous and anthracite; Pennsylvania produces more coal than any other of the 30 states with RPSs in place (US Energy Information Administration, 2018). Pennsylvania's coal industry has declined dramatically in the 17 years since the RPS was passed, most directly due to the rise of cheap natural gas (Rhys and Garner, 2020). However, the RPS preserves an ongoing value capture opportunity via the industry's wasteful legacies, notably in the form of waste coal. Waste coal, also colloquially termed "culm", "gob", or "boney," is a discarded byproduct of the commercial coal mining process. It refers to low-energy matter, often combined with other inert minerals, that is mechanically sorted out from the more energy-rich anthracite or bituminous coal. In Pennsylvania, waste coal piles cover an aggregate area of 8,500 acres, or about two billion cubic yards, according to the anthracite industry interest group ARIPPA, split equally between the anthracite and bituminous coal regions (The Coal Refuse Dilemma: Burning Coal for Environmental Benefits, 2016). The piles "resemble barren and dark mountains" (Glenna and Thomas, 2010, page 859). Pennsylvania is home to 15 of the 19 US power facilities that burn waste coal as their primary fuel. Together, Pennsylvania waste coal facilities burn more than 13 billion pounds of waste coal annually (Food and Water Watch, 2018), contributing five percent of the state's electricity generation (Legere, 2015).

Coal refuse deposits garner concern from a wide array of actors. Because the piles are volatile and can spontaneously combust or be ignited by lightning or people (McNay, 1971), among top concerns is the risk of fire and associated toxic air pollution. In 2014, for example, a seven-acre coal refuse site near Simpson, PA burned for several months (The Associated Press, 2014). Coal refuse piles also pollute waterways by leaching iron, manganese, aluminum, and acid drainage (Energy Justice Network, n.d.). However, there are long-standing tensions between those who favor leaving the deposits in place and adopting a landscape remediation approach, and those who believe the best approach to addressing the risks associated with waste coal deposits is to harness it for energy. According to ARIPPA (2015) "if coal refuse from these sites is used as fuel… all of the problems associated with coal refuse piles are permanently addressed." Environmental and energy justice advocates on the other hand, including ActionPA, Citizen Power, Pennsylvania Environmental Network, Student Environmental Action Coalition, Green Part of Pennsylvania, Sierra Club-Pennsylvania Chapter, PennEnvironment, State PIRGs, and the Clean Air Council (Skinner and Brown, 2011), argued that burning waste coal is even more toxic than traditional coal sources, especially in terms of mercury emissions, and that remediating coal refuse deposits through methods such as planting beach grass are highly effective and cost-efficient (Energy Justice Network, n.d.).

As reported in the *Pittsburgh Post-Gazette*, representatives from the Pennsylvania Department of Environmental Protection have sided with energy industry executives in claiming that "there is a special place" for waste coal in the state's energy makeup (Legere, 2015). Glenna and Thomas' (2010) examination of the policy-making process that led to coal waste's inclusion in the state's renewable energy portfolio highlights the governance and legitimacy tensions that ultimately informed the state's decision to include waste coal in its RPS. The authors make clear that Pennsylvania's resource dependency on the coal industry informed the state's decision. Specifically, according to a representative who served in the Pennsylvania Department of Environmental Protection at the time the RPS was being debated and who the authors interviewed for their study, policymakers decided to include waste coal in the RPS policy in order to mitigate the "coal lobby's opposition" to the policy (Glenna and Thomas, 2010, page 861).

For their part, coal waste energy producers' argument for inclusion in the RPS rested on their assertion that while burning coal waste for electricity production provided broad economic and environmental benefits, waste coal's low energy efficiency made the industry uncompetitive without additional incentives. Including coal waste in the RPS, therefore, would bolster this fuel source by creating demand for energy generated from waste coal (Glenna and Thomas, 2010). As explained by Skinner and Brown (2011, page 238), the alternative energy credits awarded to coal waste facilities through the RPS "provide a source of additional revenue that can help provide long term financing for qualifying facilities." In sum, including waste coal as an eligible energy source in the state's RPS reflects the coal industry's influence on Pennsylvania renewable energy policy development, and the enduring tail of that influence in a changing energy system.

Forest Debris in Oregon's Renewable Portfolio Standard

Three years after the Oregon state legislature passed the Oregon Renewable Energy Act (Senate Bill 838) establishing the state's RPS, the editorial board of *The Oregonian* editorial board published a strong commentary on biomass energy's place in the RPS: Oregon's "forest debris as gold" (2010). This editorial was fueled by an imminent decision before the US Environmental Protection Agency concerning whether biomass should be regulated with the same carbon restrictions as coal, or be classified as a renewable source of energy (Zeller, 2010). These classification politics emerged in the context of Oregon's history of friction between loggers and environmentalists, and the contested science of biomass's carbon neutrality.

Logging has been a central feature of Oregon's economy since the early 1900s (Robbins, 2006). After World War II, the housing construction boom cemented Oregon's timber industry's national significance and yielded steady employment in places like Coos Bay, deemed the "Lumber Capital of the World" (Robbins, 2006). Federal lands in Oregon also became increasingly important to the timber industry during the 1950s and 60s as private lands were diminished by clearcutting practices (Rajala, 1998). During the 1990s, however, logging reductions on federal forest lands were put in place to protect sensitive habitats for the newly endangered Northern Spotted Owl (Buursma, 1989). Within five years, Oregon's timber production dropped by nearly half, with logging on federal lands down by 90% (Barnum et al., 2010). Smaller towns and rural communities across Oregon were severely impacted by the industrial decline and job loss (Freudenburg et al., 1998; Robbins, 2019). Protests highlighted by national media brought attention to a "holy war over the use of public lands" (Buursma, 1989). The discourse of environmentalism versus labor in Oregon, critiqued by political ecologists (Prudham, 2005), persisted through efforts by the Trump Administration to reduce the power of the Endangered Species Act in a push to revive logging industries (Bull, 2020; Loomis, 2019).

This context of forest industry decline has shaped the carbon politics of biomass and its inclusion in the state's RPS. The state's policy allows electricity generated from biomass—material from hardwood timber harvested on private, managed timberlands (whole trees)—or biomass byproducts such as spent pulping liquor ("black liquor" resulting from converting wood into wood pulp) and woody debris from harvesting or thinning "to improve forest or rangeland ecological health and to reduce uncharacteristic stand replacing wildfire risk" (Avakian, 2007, page 3). Despite widespread concerns about the negative environmental implications of biomass for greenhouse gas emissions and local air pollution (Hudiburg et al., 2011; Johnson, 2009; Miles and Miles, 1992), industry activists, community organizations, and government representatives have advocated for biomass to be viewed not only as a renewable fuel source, but also a carbon-neutral source of energy. Indeed, the politics of carbon emissions have figured centrally in debates over biomass energy, especially in the proposed biomass conversion of Oregon's only remaining coal power plant (Flatt, 2019). Additionally, forest ecology, type of woody biomass, processing, and temporalities of carbon storage/sequestration in trees vary life-cycle carbon emissions (Creutzig et al., 2015; Lamers and Junginger, 2013; Luyssaert et al., 2008; Röder et al., 2015; Zanchi et al., 2012). This uncertainty at the science-policy interface can be exploited by different groups and shape the types of biomass included in states' RPSs, even though they may increase net carbon emissions (Zeller-Powell, 2011).

These carbon and classification politics led Oregon's legislators to mobilize in 2010 for a three-year exemption from Clean Air Act regulations; specifically, rules regarding how carbon emissions are treated in permits for new biomass fired units.[3] The exemption was treated as a win for Oregon's forestry industry and further motivation for expanding biomass energy

[3] Then EPA Administrator, Lisa Jackson, said in a letter to Senator Merkley that this CAA exemption would be an important effort to reduce national reliance on fossil fuels. The letter is available here: https://www.merkley.senate.gov/imo/media/doc/Merkley_Biomass_011211.pdf.

projects. As Senator Merkley explained: "Oregon is poised to grow into a world leader in biomass energy production. Today's decision marks a victory for rural Oregon, timber communities, and the future of the industry in our state" (Merkley, 2011). Recent updates to Oregon's RPS have refocused efforts on small-scale biomass, with a carve-out requirement created in 2016 for at least 8% of aggregate electrical capacity from community renewable energy projects and combined heat and power facilities using biomass (Senate Bill 1547). In 2018, amid the ongoing carbon controversy and new limits on large biomass generation inclusion in the community renewable carve-out,[4] the EPA declared biomass electricity generation plants carbon neutral, sparking a new set of concerns among scientists and environmental justice activists (Moomaw, 2018).

Debates over the definition of biomass as renewable and low-carbon intersect with ongoing environmental justice concerns in Oregon. Battles over the permitting of biomass facilities across the state cited the health impacts these generation facilities have on local communities, and argued that the facilities were a net negative for climate change (Arkin, 2010; Arkin et al., 2012; Chirillo). Environmental advocates more broadly position biomass against other sources of renewable electricity generation to show alternatives are less carbon intensive, exposing a "biomass loophole" in states' RPSs (Fairley, 2012). As evidenced by recent work on the uneven distribution of environmental impacts of biomass facilities (Koester and Davis, 2018; Mittlefehldt, 2018; Mittlefehldt and Tedford, 2014), it is likely that these racialized environmental injustices will continue to prompt critiques of biomass as a carbon-mitigation strategy, despite its universal inclusion in RPSs.

Livestock Manure in North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard

Our last case focuses on the inclusion of a set-aside for residual livestock waste in North Carolina's RPS. North Carolina is one of the country's largest producers of both pork and poultry. It is the second largest pork producing state in the United States, with almost 12% of the country's hog and pig inventory (USDA, 2016). According to the 2012 USDA Agricultural Census, the state's hog and pig industry is worth \$2.87 billion (USDA National Agricultural Statistics Service, 2012). Historically, US pork production was dominated by operations with fewer than 5,000 hogs and pigs. However, larger operations began to eclipse small-scale pork production in the mid-1990s. By 2014, operations with 5,000 or more animals generated 93% of annual pork production—an increase of over 340% over 1994 levels (USDA, 2016). This industrial-scale production accounts for almost 97% of North Carolina's hog and pig sales (\$2.78 billion) (USDA National Agricultural Statistics Service, 2012). In sum, in North Carolina, "pig business is big business" (Maier, 2015). The state is also a lead producer of poultry. According to the North Carolina Poultry Federation, poultry is the state's primary agricultural industry, making up almost 42% of North Carolina's total farm income. North Carolina ranks second nationally in terms of total turkey production, and third nationally in terms of total poultry production (North Carolina Poultry Federation).

[4] In 2017, Senate Bill 339 was enacted to limit the amount of qualifying electricity generated at any single biomass facility that can be used to fulfill RPS 8% carve-out requirements to 20 MW for large utilities.

As the state's livestock operations have become increasingly industrialized, animal waste generation has grown more concentrated. Together, the state's hog and poultry operations produce more than 10 million gallons of fecal waste each year (Philpott, 2016). In industrial pork production, storage and treatment of waste is typically in wastewater "lagoons," which have become a significant environmental and health concern—including as a source of methane, a high potency greenhouse gas (Cole et al., 2000). Industrial poultry waste, generally stored in windrows, contains highly concentrated levels of arsenic (Christen, 2001). More regional adverse impacts from industrial-scale animal waste systems include water contamination with pathogens, pharmaceuticals, heavy metals, hormones, antibiotics, and pesticides (Burkholder et al., 2007), arsenic contamination in surface soils (Christen, 2001), and respiratory ailments in young people (Mirabelli et al., 2006).

These hazards are exacerbated by the hurricanes that batter the state's coastal regions. In North Carolina, industrial poultry and pork production is concentrated in the state's eastern lowlands. These low-lying regions, whose residents are predominantly people of color (EWG; Wing and Johnston, 2014), are particularly vulnerable to hurricanes and their effects. Flooding has caused animal waste leech pools to overflow, hastening the spread of toxicants into surrounding areas. In 2018, for example, in the days following Hurricane Florence, data released by the North Carolina Department of Environmental Quality stated that at least 110 hog waste lagoons had already, or were imminently poised to release waste into waterways and surrounding areas (Pierre-Louis, 2018). The Environmental Working Group's analysis in the days following Florence was even more dire. According to the group, there were "926 concentrated animal feeding operations (CAFOs) housing more than 3.8 million hogs and 578 poultry CAFOs holding an estimated 35 million fowl in areas where the National Weather Service said flooding was 'occurring or imminent'" (EWG). With climate change, storms like Florence are predicted to intensify, increasing exposure risks for those living in the region.

The mounting challenges posed by industrial-scale animal waste have been formative in shaping the state's RPS. In 2007, North Carolina's state legislature passed Senate Bill 3—the state's first renewable energy and energy efficiency portfolio standard. This legislation included a carve-out for animal waste sources. It is the only state with an RPS that calls for an animal waste carve-out (Maier, 2015). The specific technologies through which energy is harnessed from animal waste to fulfill the carve-out requirement include direct combustion and methane gas capture for conversion to steam and electricity production (Holbrook, 2019; Walton, 2016). As reported in regional news outlets, the state's poultry industry played a central role in lobbying for the poultry waste carve-out (Mitchell and Romoser, 2008). One of the bill's main sponsors was state senator Charlie Albertson (D-Duplin), whose district hosts one of the highest concentrations of hog and poultry facilities in the state. According to the *Winston-Salem Journal*, Albertson "was the one who requested" the carve-outs for using poultry and swine waste to generate power because they "will help farmers with waste management" (Holbrook, 2019). Stephen De May, the president of Duke Energy North Carolina, which purchases renewable energy credits from animal waste conversion facilities, has also contributed that using animal waste as fuel "supports the important agriculture industry in North Carolina" (Brown, 2019).

However, both environmental and energy justice advocates maintain that the animal waste carve-outs perpetuate industrial animal production systems that are detrimental to human and environmental health, and fundamentally question the argument that livestock waste is an energy source that should be incentivized alongside cleaner sources. According to the organization Food and Water Watch (2019), incentivizing animal waste combustion

> entrenches factory farms by creating a market for the huge volumes of manure they produce. Investing in the massive infrastructure needed to produce biogas wastes critical resources that should be used to shift us toward real renewable energy.

Likewise, Ayo Wilson of the NC Environmental Justice Network and NC WARN (two North Carolina-based environmental justice organizations), argues that animal waste-derived "biogas isn't a solution as it stands right now because it fails to provide a complete remedy and threatens further entrenchment of an industry that consciously operates on white supremacy and destructive capitalism" (Food & Water Watch, 2019).

Discussion and Conclusions

How are we to interpret these controversial industrial-political bids for renewables classification, particularly toward developing industrial political ecology's broader capacity to evaluate such projects? The brevity and selective nature of these examples means that their insights remain suggestive rather than conclusive. Nevertheless they clearly support our central argument that classifying and incentivizing particular energy sources as renewable is a political process, rooted in specific trajectories of industrial development. However, what *kinds* of political projects are we looking at? Some clear cross-cutting themes emerge here.

First, furthering questioning of incumbency in renewable energy transition, the cases here highlight the ability of "dirty" and carbon-intensive sectors to make strategic use of renewable energy classification. Distinct from the resistance emerging against renewables and RPSs after the policies' "fog of enactment" (Stokes, 2020) has been dispelled, we find other incumbent industries and regional political lobbies moving to *appropriate* the renewable label. One takeaway here is the room for rebranding available to carbon-intensive incumbents historically outside the formal energy sector (Oregon timber and North Carolina agro-industry). Another is the complexity of fossil industry encounters with renewables (Pennsylvania waste coal). With the 2004 RPS, Pennsylvania's coal lobby most evidently seized an opportunity to extract concessions within a new RPS and more nascent renewables space in an era before booms in cheap natural gas and later renewables sharpened a more existential threat to the industry. This decline has lessened US coal's potential for actual effective resistance to renewables, notwithstanding the experience's traction in politics of racialized grievance (Rhys and Garner, 2020). Echoing Glenna and Thomas (2010), it is nonetheless significant that the incumbent industry flexed its former muscle by attempting to rework definitions in its favor rather than pursue deeper intransigence. Today, that waste-based strategy offers lingering value-capture opportunities for Pennsylvania coal that are distinct from other politicized tail-end exactions like stranded cost payments extracted from taxpayers or utility ratepayers (Stokes, 2020).

Second, such moves to exercise definitional power suggest obvious questions of opportunism and "greenwashing." The cases demonstrate regionally powerful incumbent industries seizing (and governments creating) political opportunities—the crafting of RPS policies—as pathways to extend value-capture. For timber and livestock agriculture, these opportunities include new entry into the contemporary energy sector. In this space, these industries have the potential to exploit the renewables sector's openness to a raft of technologies, combined with the *political* opportunities of malleable RPS instruments and state governments' institutional uncertainty with a rapidly evolving sector. Such opportunism might also encompass the discovery of unexpectedly cheap or profitable ways of resolving existing waste challenges, and thus shallower forms of firm or sectoral greenwashing. These moves reflect a history of quickly abandoned, token, and/or deceptive incumbent-industrial redirections into the renewables space—for example, US oil and industrial conglomerate acquisitions of solar start-ups in the 1970s (Jerneck, 2017) or BP's abortive and widely panned 'Beyond Petroleum' rebranding in the mid-2000s—and a valid ongoing danger of such maneuverings. Certainly, diagnosing and combatting greenwashing should be central to industrial political ecology's praxis, as with political ecology more generally. Industrial political ecology must continue to evaluate flaws in industries' environmental knowledge claims and their failures to establish or meet reasonable standards of environmental performance.

The greenwashing question is particularly applicable here because of the controversial materialities of these waste-to-energy resources, and corresponding weaknesses in climate change mitigation claims based upon them. RPSs are overtly supported for their contribution to reducing greenhouse gas emissions, yet processing and combusting all of the waste streams assembled here—from livestock wastes and waste coal to biomass from forest debris, milling wastes, or even whole trees—releases carbon dioxide and other other pollutants. Advocates argue that these processes usefully swap a high-potency greenhouse gas for a less damaging one (e.g., methane generated in manure lagoons for lower-potency carbon dioxide emitted in methane combustion), and that carbon dioxide emissions from biomass burning are rendered unproblematic in a 'circular' bioenergy economy (i.e. because as non-fossil fuels, this does not represent a net atmospheric addition). Yet many surrounding knowledge claims have provoked contestation. The carbon calculus of biomass resources in Oregon is particularly illustrative, as it highlights a science-policy contestation at the center of debates over controversial renewables. Advocates such as former EPA Administrator Scott Pruitt centrally maintain that biomass is 'carbon-neutral' (Science News Staff, 2018). This claim has been met with significant dissent by the scientific community, notably around the unconsidered full life-cycle emissions of forestry practices (Nian, 2016). Underlying all of this is the essential point that carbon accounting is a subjective practice. As Gifford (2020, page 5) notes,

> the measurement systems used to account for carbon involve complex interactions between political interests, scientific claims, and the material world... and the concepts used to determine measurement, like 'baselines' and 'additionality,' are deeply subjective and remain open to interpretation.

This points to a necessary question of both carbon accounting in renewable energy transitions (i.e. how do RPSs contribute to decarbonization), and how wastes should or should not be valorized by policy tools such as renewable energy credits or biomass producer tax credits, as in Oregon.

Third, these cases together underscore how particular material properties of wastes, and their framing, condition opportunities for different kinds of value capture within the renewable energy arena. As the North Carolina case demonstrates, framing methane-producing animal manure as a renewable energy source in an effort to capture value is explicitly reflected in statements by industries that have emerged at the intersection of livestock agro-industry and energy production.

As Al Tank, CEO of Revolution Energy Systems, which operates two manure-to-energy facilities in NC's Duplin County, the heart of the state's industrial hog production region, stated, "We should be talking about it in terms of 'waste-to-value' instead of 'waste-to-energy' projects… We are at the very beginning of 'waste-to-value' in the swine sector, and the North Carolina industry has the potential to be the undisputed leader in the U.S." (Maier, 2015). Kelly Zering, an agricultural economist at NC State echoes this framing by suggesting that the "main appeal of biogas for the swine industry is the opportunity to turn a byproduct into an asset" (Ouzts, 2017). These two quotes demonstrate both dimensions of an intensive/extensive value dialectic (Walker, 2016). On the one hand, incumbent industries like pork producer Smithfield Foods, Inc. and Duke Energy are investing in new technologies to capture methane from decomposing feces for conversion to usable energy. On the other, hog production facilities once dependent on importing electricity are also now replacing or supplementing their own energy consumption with energy derived from pig waste, thereby reducing their operating costs (Maier, 2015).

Moreover, these dynamics resonate with Romero's (2015, 2016) historical industrial analysis, which explores how re(e)valuation of industrial wastes can generate radically *novel* sectors, not simply reduce or selectively 'mine' (Knapp, 2016) waste streams to increase productivity and profitability in existing industries and production lines (a prevailing imaginary in mainstream industrial ecology). In Romero's important case, fossil energy-industrial pollutants were transmuted into the feedstocks and material foundation of the new agro-chemicals industry. Walker (2016) conceptually underlines the importance of such qualitative deepenings in capitalist value-capture and accumulation, which have historically emerged from other unexpected places. The cases here situate such schemes anew within discussion of energy transitions and a prospective green industrial revolution. Building on these insights, we suggest that industrial political ecology must continue to explore the modes of institutional (re)organization and/or new sector emergence necessary for capturing value from waste, particularly under the guise of a green economy—a political economic process *and* a knowledge construction project.

Fourth, and crucially, central to industrial political ecology's praxis must be its racial, economic, and environmental justice commitments (Huber, 2017). To crystallize what we face in our cases: what was once an externality, often a burden on low-income folks and communities of color, is internalized as a source of value. Coal waste, woody debris, and pig and chicken shit were once devalued materials accumulating in space. Capital's unrelenting search for surplus value has made them profitable via new modes of valorization including policy instruments, technological innovations, and labor. Even if waste-to-energy projects live up to their own defined criteria for "green" action (not a given) we must ask what waste problems and pathways of socio-ecological degradation these selective rebrandings ignore—and may thereby perpetuate and deepen. Indeed, the benefits of these efforts to capture value are unevenly borne. In North Carolina, for example, some of the cleanest technologies developed to capture methane from hog waste have been implemented in predominantly white regions of the state, whereas the majority of hog operations are located in communities of color (Ouzts, 2017). In parallel, the state's intent to incentivize manure-to-energy through its RPS may have the effect of consolidating hog farms to take advantage of economies of scale (Longest, 2020; Ouzts, 2017). This coupled dynamic exacerbates both a pattern of farm loss among eastern North Carolina's Black communities that has persisted since the 1990s (Ladd and Edward, 2002), as well as a deeply-ingrained history of the state implementing racially discriminatory energy systems in its eastern region (Harrison, 2016). In Pennsylvania, analysis conducted by Food & Water Watch has similarly identified that the state's fossil-based power plants are disproportionately located near areas with a higher proportion of people of color. Whereas the state identifies approximately 25% of its census tracts as environmental justice communities, almost 50% of the census tracts within three miles of fossil-powered facilities are environmental justice tracts (Food & Water Watch, 2018). The harmful health effects of these facilities are most acute in areas surrounding coal-burning power plants (Krieger et al., 2016). And while the distributional effects of biomass are less obvious, the case of the siting and approval process for Seneca biomass facility in Oregon mirrors the trends discussed here, and more broadly of waste-to-energy incinerators across the country (Donahue, 2018; Rootes and Leonard, 2009). The issue of unequal distribution of localized pollution in each case speaks to a central problem of environmental justice in controversial renewable energy geographies.

In conclusion, we have argued here using the case of US RPSs and a set of "controversial" renewables that the politics of classification in the renewable energy sector demand ongoing scrutiny, particularly as they take shape and assume power within emerging green industrial policies. We have likewise maintained that these claims on renewable identity present under-examined economic opportunities for a range of unlikely incumbent industries, including environmentally embattled ones. Similarly, they suggest pathways for governments that may wish to support such incumbent industries in processes of new value capture and/or rebranding via renewable classification.

Evaluating governmental institutions as both sites (via processes like RPS-setting) and *actors* in these classification politics and evolving industrial-political geographies of energy transition, as we have begun to do through these three cases, is one important question for further research in industrial political ecology—not least because more established renewables like solar may deploy similar regionally distinct incentives and pose similar environmental/justice dilemmas. In the US context, more empirical and interpretive research is needed to explore why some state RPS policies now include specific industrial strategies and others do not, and to examine the range of different industries, *kinds* of industries, and industrial trajectories incentivized in such policies. The balance of industrial versus governmental power and agency in such politics is complex and contingent. Nonetheless, in evaluating questions of incumbency, industrial political ecology must develop situated principles for distinguishing state capture by opportunistic industries from more justice-minded governmental interventions to mitigate the costs of transition to a low-carbon economy.

On this last point, industrial political ecological research must continue to clarify the limits of industrial rebranding and waste-to-value bids for rebranding. One the one hand, as renewables rise, it would be premature to interpret the mere presence of incumbent industries in these spaces as greenwashing. One of industrial political ecology's contributions may be an analytical openness to the more transformative possibilities of a renewable energy economy, including unexpected places that recapturing and repurposing industrial wastes might lead. Similarly, material processes of utilizing 'externalities' do not *necessarily* entrench processes of dispossession and contamination: they may present possibilities for liberatory alternatives. On the other hand, further industrial political ecological scholarship on energy must take seriously a central insight from theorists of racial capitalism: that the production of differential value—the process of rendering bodies and lives expendable or of lower value—is essential to capital accumulation (Melamed, 2015; Pulido, 2016b). Waste and wasting are more than a matter of simple externalities; they are internal to the creation of capitalist value. Therefore, research must scrutinize how environmental injustices sustain particular modes of valorization, and foreclose industries' potential for transformation.

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References

ARIPPA, 2015, "Coal Refuse White Paper", https://arippa.org/wp-content/uploads/2018/12/ARIPPA-Coal-Refuse-Whitepaper-with-Photos-10_05_15.pdf

Arkin L, 2010, "Biomass is not Oregon's clean-energy future as currently promoted" *The Oregonian*, https://www.oregonlive.com/opinion/2010/10/biomass_is_not_oregons_clean-e.html

Arkin L, Mendoza M, Jordan-Cascade J, Guzman A, Jordan-Cascade J, Lottinville W, 2012, "Environmental Justice In West Eugene: Families, Health, and Air Pollution", Beyond Toxics

Avakian B P, 2007, "Oregon Senate Bill 838: Oregon Renewable Energy Act", https://olis.leg.state.or.us/liz/2007R1/Downloads/MeasureDocument/SB838/Enrolled

Baka J, 2014, "What wastelands? A critique of biofuel policy discourse in South India" *Geoforum* **54** 315–323

Baka J, Vaishnava S, Forthcoming, "The evolving borderland of energy geographies" *Geography Compass*, https://onlinelibrary.wiley.com/doi/abs/10.1111/gec3.12493

Bandyk M, 2020, "Virginia approves 100% clean energy legislation, pushing state toward 2.4 GW storage, RGGI" *Utility Dive*, https://www.utilitydive.com/news/virginia-clean-energy-legislation-pushes-state-toward-storage-rggi/572349/

Barbose G, 2019, "U.S. Renewables Portfolio Standards 2019 Annual Status Update", Lawrence Berkeley Lab Electricity Markets and Policy Group, eta-publications.lbl.gov/sites/default/files/rps_annual_status_update-2019_edition.pdf

Barbose G, Bird L, Heeter J, Flores-Espino F, Wiser R, 2015, "Costs and benefits of renewables portfolio standards in the United States" *Renewable and Sustainable Energy Reviews* **52** 523–533

Barca S, Bridge G, 2015, "Industrialization and environmental change", in *The Routledge Handbook of Political Ecology* (Routledge, London and New York), pp 366–77

Barnum P, Cloughesy M, Kvamme D, 2010, "Federal Forestland in Oregon: Coming to Terms with Active Forest Management of Federal Forestland", Oregon Forest Resources Institute, Portland, OR, https://oregonforests.org/sites/default/files/2017-08/Federal_Forestlands.pdf

Behrsin I, 2019a, “Green Energy from Garbage? A Case Study of Municipal Solid Waste’s Contested Inclusion in Maryland’s Renewable Portfolio Standard” *Case Studies in the Environment* **3**(1) 1–7

Behrsin I, 2019b, “Rendering Renewable: Technoscience and the Political Economy of Waste-to-Energy Regulation in the European Union” *Annals of the American Association of Geographers* **109**(5) 1362–1378

Behrsin I, De Rosa S P, 2020, “Contaminant, Commodity and Fuel: A Multi-sited Study of Waste’s roles in Urban Transformations from Italy to Austria” *International Journal of Urban and Regional Research* **44**(1) 90–107

Berry T, Jaccard M, 2001, “The renewable portfolio standard:: design considerations and an implementation survey” *Energy Policy* **29**(4) 263–277

Bigger P, Millington N, 2020, “Getting soaked? Climate crisis, adaptation finance, and racialized austerity” *Environment and Planning E: Nature and Space* **3**(3) 601–623

Block F L, Keller M R, 2011 *State of Innovation: The U.S. Government’s Role in Technology Development* (Routledge, Boulder, CO)

Bridge G, 2014, “Resource geographies II: The resource-state nexus” *Progress in Human Geography* **38**(1) 118–130

Bridge G, 2018, “The map is not the territory: A sympathetic critique of energy research’s spatial turn” *Energy Research & Social Science* **36** 11–20

Bridge G, Gailing L, 2020, “New energy spaces: Towards a geographical political economy of energy transition”: *Environment and Planning A: Economy and Space*, https://journals.sagepub.com/doi/10.1177/0308518X20939570

Brown K, 2019, “NC Plant Turns Poultry Waste Into Electricity”, https://www.wfdd.org/story/nc-plant-turns-poultry-waste-electricity

Bulkeley H, Castán Broto V, 2013, “Government by experiment? Global cities and the governing of climate change” *Transactions of the Institute of British Geographers* **38**(3) 361–375

Bull B, 2020, “Trump Pledged To Restore Oregon’s Timber Industry. Little Has Changed Under His Presidency.” *Oregon Public Broadcasting*, https://www.opb.org/news/article/president-trump-timber-industry-jobs-oregon-economy/

Burkholder J, Libra B, Weyer P, Heathcote S, Kolpin D, Peter S. T, Wichman M, 2007, “Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality” *Environmental Health Perspectives* **115**(2) 308–312

Buursma B, 1989, “OWL ISSUE RUFFLES OREGON TIMBER FIRMS` FEATHERS - Chicago Tribune” *Chicago Tribune*, https://www.chicagotribune.com/news/ct-xpm-1989-07-23-8902190731-story.html

Carley S, Miller C J, 2012, “Regulatory Stringency and Policy Drivers: A Reassessment of Renewable Portfolio Standards: Regulatory Stringency and Policy Drivers” *Policy Studies Journal* **40**(4) 730–756

Carton W, 2016, “Money for nothin’ and coal for free: ‘Technology neutrality’ and biomass development under the Flemish tradable green certificate scheme” *Geoforum* **70** 69–78

Chirillo S, “Oregon Biomass Battleground | Energy Justice Network” *Energy Justice Network*, http://www.energyjustice.net/content/oregon-biomass-battleground

Christen K, 2001, “Chickens, manure, and arsenic” *Environmental Science & Technology* **35**(9) 184A-185A

Christophers B, 2017, “Climate Change and Financial Instability: Risk Disclosure and the Problematics of Neoliberal Governance” *Annals of the American Association of Geographers* **107**(5) 1108–1127
Cole D, Todd L, Wing S, 2000, “Concentrated swine feeding operations and public health: a review of occupational and community health effects.” *Environmental Health Perspectives* **108**(8) 685–699
Cooper M H, 2015, “Measure for measure? Commensuration, commodification, and metrology in emissions markets and beyond” *Environment and Planning A* **47**(9) 1787–1804
Creutzig F, Ravindranath N H, Berndes G, Bolwig S, Bright R, Cherubini F, Chum H, Corbera E, Delucchi M, Faaij A, Fargione J, Haberl H, Heath G, Lucon O, Plevin R, Popp A, Robledo-Abad C, Rose S, Smith P, Stromman A, et al., 2015, “Bioenergy and climate change mitigation: an assessment” *GCB Bioenergy* **7**(5) 916–944
Donahue M, 2018, “Report: Waste Incineration: A Dirty Secret in How States Define Renewable Energy” *Institute for Local Self-Reliance*, https://ilsr.org/waste-incineration-renewable-energy/
DSIRE, 2015, “Colorado Renewable Energy Standard”, http://programs.dsireusa.org/system/program/detail/133
DSIRE, 2016, “Renewable Portfolio Standard Policies”, https://3vq5kdns38e1qxlmvvqmrzsi-wpengine.netdna-ssl.com/wp-content/uploads/2017/06/RPS-DSIRE.jpg
DSIRE, 2018, “Pennsylvania Alternative Energy Standard Program Overview”, https://programs.dsireusa.org/system/program/detail/262
Energy Justice Network, n.d., “Waste Coal” *Energy Justice Network*, http://www.energyjustice.net/coal/wastecoal
Estes N, 2019 *Our History Is the Future: Standing Rock versus the Dakota Access Pipeline, and the Long Tradition of Indigenous Resistance* (Verso, London ; New York)
EWG, “Analysis of Sites Hit by Storm Reveals Potential Release of Billions of Gallons of Manure and Urine” *EWG*, https://www.ewg.org/release/map-florence-drenched-thousands-north-carolina-cafos-and-animal-waste-pits
EWG, “Interactive Map: Concentrated Animal Feeding Operations by Census Block Group”, http://www.ewg.org/interactive-maps/2016_north_carolina_animal_feeding_operations_byblockgroup.php
Fairhead J, Leach M, Scoones I, 2012, “Green grabbing: a new appropriation of nature?” *Journal of peasant studies.* **39**(2) 237–261
Fairley P, 2012, “The Inconvenient Science of Biomass Power” *IEEE Spectrum: Technology, Engineering, and Science News*, https://spectrum.ieee.org/energywise/energy/renewables/the-inconvenient-science-of-biomass-energy
Flatt C, 2019, “PGE Looks To Renewable Energy As Boardman Coal Plant Closes” *Oregon Public Broadcasting*, https://www.opb.org/news/article/portland-general-electric-renewable-energy-coal-plant-closures/
Food & Water Watch, 2018, “Pernicious Placement of Pennsylvania Power Plants”, https://www.foodandwaterwatch.org/sites/default/files/rpt_1806_pagasplants_web3.pdf
Food & Water Watch, 2019, “Bio(gas)hazards: Dirty Air, Factory Farms and Climate Change Webinar”, https://www.youtube.com/watch?v=-ISG9KTNGYk

Food and Water Watch, 2018, "Fact Sheet: Pennsylvania Renewable Portfolio Standard Report Card" *Food & Water Watch*, https://www.foodandwaterwatch.org/insight/fact-sheet-pennsylvania-renewable-portfolio-standard-report-card

Forte J, Jones T, Leschke M, Martin J, Pennock A, Terada R, Wiser R, 2017, "Overview of Renewable Portfolio Standard Design Options from the U.S. Experience", Center for Resource Solutions, San Francisco, CA

Freudenburg W R, Wilson L J, O'Leary D J, 1998, "Forty Years of Spotted Owls? A Longitudinal Analysis of Logging Industry Job Losses" *Sociological Perspectives* **41**(1) 1–26

Gaul C, Carley S, 2012, "Solar set asides and renewable electricity certificates: Early lessons from North Carolina's experience with its renewable portfolio standard" *Energy Policy* **48** 460–469

Gidwani V, Reddy R N, 2011, "The Afterlives of 'Waste': Notes from India for a Minor History of Capitalist Surplus" *Antipode* **43**(5) 1625–1658

Gifford L, 2020, "'You can't value what you can't measure': a critical look at forest carbon accounting" *Climatic Change*, https://doi.org/10.1007/s10584-020-02653-1

Gilio-Whitaker D, 2019 *As Long as Grass Grows: The Indigenous Fight for Environmental Justice, from Colonization to Standing Rock* (Beacon Press, Boston)

Gilmore R W, 2007 *Golden gulag: prisons, surplus, crisis, and opposition in globalizing California* (Univ. of California Press, Berkeley, Calif.)

Glenna L L, Thomas R R, 2010, "From Renewable to Alternative: Waste Coal, the Pennsylvania Alternative Energy Portfolio Standard, and Public Legitimacy" *Society & Natural Resources* **23**(9) 856–871

Gregson N, Crang M, 2010, "Materiality and waste: inorganic vitality in a networked world" *Environment and Planning A* **42**(5) 1026–1032

Harrison C, 2016, "Race, Space, and Electric Power: Jim Crow and the 1934 North Carolina Rural Electrification Survey" *Annals of the American Association of Geographers* **106**(4) 909–931

Hirsh R F, 2001 *Power loss: the origins of deregulation and restructuring in the American electric utility system* 2. print (MIT Press, Cambridge, Mass.)

Holbrook E, 2019, "Poultry Power: North Carolina Utilities Using Turkey Waste to Generate Electricity" *Environment + Energy Leader*, https://www.environmentalleader.com/2019/12/poultry-power-north-carolina-utilities-using-turkey-waste-to-generate-electricity/

Huber M T, 2017, "Hidden Abodes: Industrializing Political Ecology" *Annals of the American Association of Geographers* **107**(1) 151–166

Huber M T, McCarthy J, 2017, "Beyond the subterranean energy regime? Fuel, land use and the production of space" *Transactions of the Institute of British Geographers* **42**(4) 655–668

Hudiburg T W, Law B E, Wirth C, Luyssaert S, 2011, "Regional carbon dioxide implications of forest bioenergy production" *Nature Climate Change* **1**(8) 419–423

Jerneck M, 2017, "Financialization impedes climate change mitigation: Evidence from the early American solar industry" *Science Advances* **3**(3) e1601861

Johnson E, 2009, "Goodbye to carbon neutral: Getting biomass footprints right" *Environmental Impact Assessment Review* **29**(3) 165–168

Jones B, Philips P, Zabin C, 2015, "Job Impacts of California's Existing and Proposed Renewables Portfolio Standard" *Center for Labor Research and Education*, http://laborcenter.berkeley.edu/job-impacts-ca-rps/

Knapp F L, 2016, "The birth of the flexible mine: Changing geographies of mining and the e-waste commodity frontier" *Environment and Planning A* **48**(10) 1889–1909

Knuth S, 2017, "Green Devaluation: Disruption, Divestment, and Decommodification for a Green Economy" *Capitalism Nature Socialism* **28**(1) 98–117

Knuth S, 2018, "'Breakthroughs' for a green economy? Financialization and clean energy transition" *Energy Research & Social Science* **41** 220–229

Knuth S, 2019, "Cities and planetary repair: The problem with climate retrofitting" *Environment and Planning A: Economy and Space* **51**(2) 487–504

Koester S, Davis S, 2018, "Siting of Wood Pellet Production Facilities in Environmental Justice Communities in the Southeastern United States" *Environmental Justice* **11**(2) 64–70

Krieger E, McPhail A, Millstein D, Shehabi A, Czolowski E, Hays J, Casey J, Shonkoff S B C, 2016, "The Clean Power Plan in Pennsylvania: Analyzing power generation for health and equity", PSE Healthy Energy, https://www.psehealthyenergy.org/wp-content/uploads/2017/04/CPP.PA_1.pdf

Kuchler M, Bridge G, 2018, "Down the black hole: Sustaining national socio-technical imaginaries of coal in Poland" *Energy Research & Social Science* **41** 136–147

Ladd A E, Edward B, 2002, "Corporate Swine and Capitalist Pigs: A Decade of Environmental Injustice and Protest in North Carolina" *Social Justice* **29**(3 (89)) 26–46

Lamers P, Junginger M, 2013, "The 'debt' is in the detail: A synthesis of recent temporal forest carbon analyses on woody biomass for energy" *Biofuels, Bioproducts and Biorefining* **7**(4) 373–385

Legere L, 2015, "Waste coal plants a poor fit with carbon emission rules" *Pittsburgh Post-Gazette*, https://www.post-gazette.com/business/powersource/2015/01/06/Waste-coal-plants-a-poor-fit-with-carbon-emission-rules/stories/201501060014

Lennon M, 2017, "Decolonizing energy: Black Lives Matter and technoscientific expertise amid solar transitions" *Energy Research & Social Science* **30** 18–27

Lepawsky J, Billah M, 2011, "Making Chains That (un)make Things: Waste–Value Relations and the Bangladeshi Rubbish Electronics Industry" *Geografiska Annaler: Series B, Human Geography* **93**(2) 121–139

Levenda A M, Behrsin I, Disano F, 2021, "Renewable energy for whom? A global systematic review of the environmental justice implications of renewable energy technologies" *Energy Research & Social Science* **71**, http://www.sciencedirect.com/science/article/pii/S2214629620304126

Longest R, 2020, "North Carolina's hog industry could turn a corner—for better or worse" *Scalawag*, https://www.scalawagmagazine.org/2020/02/nc-hog-farm-legislature/

Loomis E, 2019, "Opinion: Spotted owl protections didn't kill logging jobs; timber industry did" *The Oregonian*, https://www.oregonlive.com/opinion/2019/09/opinion-spotted-owl-protections-didnt-kill-logging-jobs-timber-industry-did.html

Luyssaert S, Schulze E-D, Börner A, Knohl A, Hessenmöller D, Law B E, Ciais P, Grace J, 2008, "Old-growth forests as global carbon sinks" *Nature* **455**(7210) 213–215

Lyon T P, Yin H, 2010, "Why Do States Adopt Renewable Portfolio Standards?: An Empirical Investigation" *The Energy Journal* **31**(3) 133–157

Maier A, 2015, “Hog wild about biogas” *Waste Today*, https://www.wastetodaymagazine.com/article/rew0815-hog-waste-to-energy-projects/
Massey D B, 1995 *Spatial divisions of labour: social structures and the geography of production* 2. ed (MacMillan, Houndmills)
Mazzucato M, 2015 *The Entrepreneurial State: Debunking public vs. private sector myths* Revised (Public Affairs, New York, NY)
McCarthy J, 2012, “Political Ecology/Economy”, in *The Wiley-Blackwell companion to economic geography* Eds T J Barnes, J Peck, and E S Sheppard Wiley-Blackwell companions to geography (Wiley-Blackwell, Chichester, West Sussex ; Malden, MA), pp 612–625
McDevitt R, 2020, “Pennsylvania’s alternative energy goals set to flatline next year, unless legislature acts” *StateImpact Pennsylvania*, https://stateimpact.npr.org/pennsylvania/2020/12/30/pennsylvanias-alternative-energy-goals-set-to-flatline-next-year-unless-legislature-acts/
McNay L M, 1971, “Coal Refuse Fires, An Environemntal Hazard”, Bureau of Mines, US Department of the Interior, Washington, D.C
Melamed J, 2015, “Racial Capitalism” *Critical Ethnic Studies* **1**(1) 76–85
Mercure M, 2020, “Northam Signs the Virginia Clean Economy Act” *Solar Industry*, https://solarindustrymag.com/northam-signs-the-virginia-clean-economy-act
Merkley J, 2011, “EPA Heeds Merkley’s Call to Clear the Path for Oregon Biomass Energy Industry | U.S. Senator Jeff Merkley of Oregon”, https://www.merkley.senate.gov/news/press-releases/epa-heeds-merkleys-call-to-clear-the-path-for-oregon-biomass-energy-industry
Miles T R Sr, Miles T R Jr, 1992, “Environmental implications of increased biomass energy use. Final report”, http://www.osti.gov/servlets/purl/10133248-1cJISc/
Millington N, Lawhon M, 2019, “Geographies of waste: Conceptual vectors from the Global South” *Progress in Human Geography* **43**(6) 1044–1063
Mirabelli M C, Wing S, Marshall S W, Wilcosky T C, 2006, “Asthma Symptoms Among Adolescents Who Attend Public Schools That Are Located Near Confined Swine Feeding Operations” *Pediatrics* **118**(1) e66–e75
Mitchell M, Romoser J, 2008, “Are litter plants worth trade-off for energy?” *Winston-Salem Journal*, https://www.journalnow.com/news/state/are-litter-plants-worth-trade-off-for-energy/article_901514c9-fb27-56e4-b317-21354349e007.html
Mittlefehldt S, 2018, “Wood Waste and Race: The Industrialization of Biomass Energy Technologies and Environmental Justice” *Technology and Culture* **59**(4) 875–898
Mittlefehldt S, Tedford C, 2014, “Benefit or Burden? Environmental Justice and Community-Scale Biomass Energy Systems in Vermont” *Environmental Justice* **7**(4) 110–114
Moomaw W, 2018, “The EPA says burning wood to generate power is ‘carbon-neutral.’ Is that true?” *The Conversation*, http://theconversation.com/the-epa-says-burning-wood-to-generate-power-is-carbon-neutral-is-that-true-95727
Moore S A, 2008, “The Politics of Garbage in Oaxaca, Mexico” *Society & Natural Resources* **21**(7) 597–610
Mulvaney D, 2014, “Are green jobs just jobs? Cadmium narratives in the life cycle of Photovoltaics” *Geoforum* **54** 178–186
Mulvaney D, 2019 *Solar power: innovation, sustainability, and environmental justice* (University of California Press, Oakland, California)

Newell J P, Cousins J J, Baka J, 2017, “Political-industrial ecology: An introduction” *Geoforum* **85**(Supplement C) 319–323
Nian V, 2016, “The carbon neutrality of electricity generation from woody biomass and coal, a critical comparative evaluation” *Applied Energy* **179** 1069–1080
North Carolina Poultry Federation, “Poultry Facts” *North Carolina Poultry Federation*, https://www.ncpoultry.org/facts/facts.cfm
North Carolina Utilities Commission, “Renewable Energy and Energy Efficiency Portfolio Standard (REPS)”, https://www.ncuc.net/Reps/reps.html
Oregon Department of Energy, “Renewable Portfolio Standard” *Oregon.gov*, https://www.oregon.gov/energy/energy-oregon/Pages/Renewable-Portfolio-Standard.aspx
Ouzts E, 2017, “Using biogas to clear the air near hog farms” *NC Policy Watch*, http://www.ncpolicywatch.com/2017/11/16/using-biogas-clear-air-near-hog-farms/
Palmer J, 2020, “Putting Forests to Work? Enrolling Vegetal Labor in the Socioecological Fix of Bioenergy Resource Making” *Annals of the American Association of Geographers* 1–16
Pellow D N, 2016, “Toward a Critical Environmental Justice Studies: Black Lives Matter as an Environmental Justice Challenge” *Du Bois Review: Social Science Research on Race* **13**(02) 221–236
Pennsylvania Public Utility Commission, 2017, “Alternative Energy and Economic Development in Pennsylvania”, https://www.puc.state.pa.us/general/consumer_ed/pdf/AEPS_Fact_Sheet.pdf
Philpott T, 2016, “Hurricane Matthew killed millions of farm animals in North Carolina” *Mother Jones*, https://www.motherjones.com/environment/2016/10/hurricane-matthew-killed-animals-hog-poop/
Pierre-Louis K, 2018, “Lagoons of Pig Waste Are Overflowing After Florence. Yes, That’s as Nasty as It Sounds.” *The New York Times*, https://www.nytimes.com/2018/09/19/climate/florence-hog-farms.html
Pike A, 2020, “Coping with deindustrialization in the global North *and* South” *International Journal of Urban Sciences* 1–22
Prudham W S, 2005 *Knock on Wood: Nature as Commodity in Douglas-Fir Country* (Routledge, New York)
Pulido L, 2016a, “Flint, Environmental Racism, and Racial Capitalism” *Capitalism Nature Socialism* **27**(3) 1–16
Pulido L, 2016b, “Geographies of race and ethnicity II: Environmental racism, racial capitalism and state-sanctioned violence” *Progress in Human Geography* 0309132516646495
Pulido L, Kohl E, Cotton N-M, 2016, “State Regulation and Environmental Justice: The Need for Strategy Reassessment” *Capitalism Nature Socialism* **27**(2) 12–31
Rabe B G, 2004 *Statehouse and greenhouse: the emerging politics of American climate change policy* (Brookings Institution Press, Washington, DC)
Rabe B G, 2006 *Race to the top: the expanding role of U.S. state renewable portfolio standards* (Pew Center on Global Climate Change, Arlington, VA)
Rajala R A, 1998 *Clearcutting the Pacific Rain Forest: Production, Science, and Regulation* (UBC Press, Vancouver)
Rhys D, Garner T, 2020, “In Pennsylvania coal country, miners forgive Trump for failed revival” *Reuters*, https://www.reuters.com/article/us-usa-election-trump-coal-insight-idUSKBN26L1SB

Robbins W G, 2006 *Hard Times in Paradise: Coos Bay, Oregon* (University of Washington Press, Seattle)
Robbins W G, 2019, "Timber Industry" *The Oregon Encyclopedia*, https://oregonencyclopedia.org/articles/timber_industry/#.XxdjF-d7mZS
Robertson M M, Wainwright J D, 2013, "The Value of Nature to the State" *Annals of the Association of American Geographers* **103**(4) 890–905
Röder M, Whittaker C, Thornley P, 2015, "How certain are greenhouse gas reductions from bioenergy? Life cycle assessment and uncertainty analysis of wood pellet-to-electricity supply chains from forest residues" *Biomass and Bioenergy* **79** 50–63
Romero A M, 2015 *The Alchemy of Capital: Industrial Waste and the Chemicalization of United States Agriculture*, UC Berkeley, https://escholarship.org/uc/item/2rh0d4df
Romero A M, 2016, "'From Oil Well to Farm': Industrial Waste, Shell Oil, and the Petrochemical Turn (1927–1947)" *Agricultural History* **90**(1) 70–93
Rootes C, Leonard L, 2009, "Environmental movements and campaigns against waste infrastructure in the United States" *Environmental Politics* **18**(6) 835–850
Schindler S, Demaria F, 2019, "'Garbage is Gold': Waste-based Commodity Frontiers, Modes of Valorization and Ecological Distribution Conflicts" *Capitalism Nature Socialism* **0**(0) 1–8
Sience News Staff, 2018, "U.S. EPA says it will define wood as a 'carbon-neutral' fuel, reigniting debate" *Science | AAAS*, https://www.sciencemag.org/news/2018/04/us-epa-says-it-will-define-wood-carbon-neutral-fuel-reigniting-debate
Skinner J, Brown M, 2011, "The Inefficiencies and Deficiencies of Waste Coal" *Vermont Journal of Environmental Law* **13**(2) 229–253
Spivey H, 2020, "Governing the Fix: Energy Regimes, Accumulation Dynamics, and Land Use Changes in Japan's Solar Photovoltaic Boom" *Annals of the American Association of Geographers* **0**(0) 1–19
Stokes L C, 2020 *Short circuiting policy: interest groups and the battle over clean energy and climate policy in the American states* (Oxford University Press, New York, NY)
Storper M, Walker R, 1989 *The capitalist imperative: territory, technology, and industrial growth* (B. Blackwell, Oxford, UK; New York, NY, USA)
The Associated Press, 2014, "Battle to extinguish PA coal fire continues" *pennlive*, https://www.pennlive.com/midstate/2014/02/battle_to_extinguish_pa_coal_f.html
The Coal Refuse Dilemma: Burning Coal for Environmental Benefits, 2016 *Power Magazine*, https://www.powermag.com/coal-refuse-dilemma-burning-coal-environmental-benefits/
The Oregonian Editorial Board, 2010, "Forest debris as 'gold' -- unless the U.S. says no" *The Oregonian*, https://www.oregonlive.com/opinion/2010/10/forest_debris_as_gold_--_unles.html
US Energy Information Administration, 2018, "Annual Coal Report 2018 - Table 6. Coal Production and Number of Mines by State and Coal Rank, 2018", US Department of Energy, Washington, D.C., https://www.eia.gov/coal/annual/pdf/acr.pdf
USDA, 2016, "U.S. Hog Industry, 1994-2014", USDA National Agricultural Statistics Service, https://www.nass.usda.gov/Publications/Highlights/2016/HogIndustryHighlights_No2016-1.pdf
USDA National Agricultural Statistics Service, 2012, "USDA - National Agricultural Statistics Service - 2012 Census of Agriculture - Volume 1, Chapter 1: State Level Data - North_Carolina", USDA National Agricultural Statistics Service,

https://www.nass.usda.gov/Publications/AgCensus/2012/Full_Report/Volume_1,_Chapter_1_State_Level/North_Carolina/
Walker R, 2016, "Value and Nature: From Value Theory to the Fate of the Earth" *Human Geography* **9**(1) 1–15
Walton R, 2016, "North Carolina project breaks ground to power state with animal waste" *Utility Dive*, https://www.utilitydive.com/news/north-carolina-project-breaks-ground-to-power-state-with-animal-waste/433039/
Wing S, Johnston J, 2014, "Industrial Hog Operations in North Carolina Disproportionately Impact African-Americans, Hispanics and American Indians", University of North Carolina, Chapel Hill, Department of Epidemiology
Zanchi G, Pena N, Bird N, 2012, "Is woody bioenergy carbon neutral? A comparative assessment of emissions from consumption of woody bioenergy and fossil fuel" *GCB Bioenergy* **4**(6) 761–772
Zeller T, 2010, "New Rules May Cloud the Outlook for Biomass" *The New York Times*, https://www.nytimes.com/2010/07/10/business/energy-environment/10biomass.html
Zeller-Powell C E, 2011, "Defining Biomass as a Source of Renewable Energy: The Life Cycle Carbon Emissions of Biomass Energy and a Survey and Analysis of Biomass Definitions in States' Renewable Portfolio Standards, Federal Law, and Proposed Legislation" *Journal of Environmental Law and Litigation* **26**