Food System Economics Commission

WORKING PAPER

Background Paper on Learning from the Political Economy of the Energy Transition

Kathryn Hochstetler

ACKNOWLEDGEMENT

This work has been supported by the Food System Economics Commission, funded by an award to the World Resources Institute (WRI) from the Norwegian Climate and Forest Initiative (NICFI), subgrant agreement no. 0581-2021.

CITATION

Hochstetler, K. (2022). Learning from the Political Economy of the Energy Transition.

CONTACT

Food System Economics Commission
contact@fsec.org

FOOD SYSTEM ECONOMICS COMMISSION

BACKGROUND PAPER ON LEARNING FROM THE POLITICAL ECONOMY OF THE ENERGY TRANSITION

KATHRYN HOCHSTETLER

Introduction

The transition processes of large and complex global systems may share important similarities that allow transferring learning about one kind of system transition to another. This is not a new observation, as it is grounded in many decades of "systems thinking" across the social sciences (Meadows 2008; Young 2017). Large literatures aim to map systems, their parts, and the relationship between parts and the whole. In the face of systems' self-maintaining quality (Meadows 2008: 2), understanding how they might evolve over time or be guided towards goals is a significant theoretical and practical challenge. General understanding of systems and their transitions may help to meet this challenge, while knowledge about some particular system transition may also illuminate analysis of another specific system transition. This paper argues that the well-advanced literature on the political economy of energy transitions offers such relevant signposts for analysis of similar potential transitions of the global food system.

One shared starting point is the need to examine the effects of multiple, quite different political economies within the broader dynamic of overall system change (Hochstetler 2021a). Energy systems transitions respond to interest structures and institutional configurations – together, a "political economy" – related to climate change and decarbonization of the energy sector. But they also reflect the interactions of quite different sets of actors and institutions who approach energy transition as, for example, the problem of creating an innovative new industrial sector for energy production or who are seeking to provide affordable access to electricity for consumers. These simultaneous political economy dynamics may reinforce each other or they may undermine each other; if the former, transition is more rapid and coherent, while if the latter, transition may be more halting or partial, even counter-productive. In the same way, the global food system has important production *and* consumption imperatives, which do not necessarily evolve in consistent ways. Transitions in those political economies may or may not be compatible with positive environmental effects for water, biodiversity, or climate (Béné, et al. 2019). Their social effects may or may not be compatible with the expectations of a just transition that does not leave the vulnerable worse off (Newell and Mulvaney 2013).

A study of transition needs some understanding of a possible endpoint or at least what would count as movement in the right direction. The multiple political economies offer different versions of what those might be, which are further detailed below. Among the many dimensions of both energy and food systems transitions, however, decarbonization is a clear first among equals for both. Climate change has already demonstrated a powerful capacity to set the starting points of both physical and social life, as extreme weather events and the apparently inexorable rise of global temperatures increasingly change the basic conditions of life around the world, often for the worse (Steffen, et al. 2015). The agenda of decarbonization also generates the sharpest opposition: very powerful actors have consistently mobilized against taking the necessary action to reduce greenhouse gases that would prevent additional future climate change (Brulle 2021; Moe 2015). Any solutions must consider the special burdens of both climate change and solutions to it for the world's poor, an issue of justice (Kashwan, et al. 2020).

Conversely, transitions in the other political economies of energy systems have been more likely to present at least the possibility of some short-term benefits or compensations for key constituencies even as they may also contribute to decarbonization, generating what climate negotiators call the "co-benefits" of some climate actions (Ürge-Vorsatz, et al. 2014). The recent passage of long-delayed climate legislation in the United States once again shows the political advantages of offering incentives versus imposing limitations and costs for reaching agreement on climate action, an advantage that even the progenitor of carbon taxes, William Nordhaus, conceded to reporters (Davenport and Friedman 2022). This is not a claim that they always provide such benefits, just that the narrative ideas around them tend to be more organized around opportunities than threats, and those have proved to widen the political coalitions around climate action – especially when the promises are actually achieved.

This paper begins by presenting the analytical dilemmas of transitions analysis in more detail and discusses strategies for accounting for both the multiple political economy dynamics and the ways they might be linked to explain system transition – or the lack thereof. After that, the paper examines more specific lessons from an examination of the political economies of energy transitions. While drawing on multiple works, it pays particular attention to the unfolding of such transitions in two important emerging powers, grounded in a study of the growth (and stagnation) of wind and solar powered electricity in Brazil and South Africa (Hochstetler 2021a). Study of these large emerging powers complements the existing literature on energy transitions, much of which has focused on the experiences of advanced industrial democracies. The paper concludes with some broader reflections about possible contributions and limits of using the experience of energy systems transition to discuss food systems change.

Analysing Systems Transitions: Analytical Choices and Frameworks

Even non-specialists will recognize that a complex phenomenon like a global energy system or a global food system has many component parts, which move unevenly toward outcomes. Scholars may choose to abstract starkly from that complexity, deriving figurative analyses of macro level tipping points and the like (e.g., Steffen, et al. 2015; Westley, et al. 2011). Others abstract instead by ignoring many of the dimensions of the system and drilling deeply into one dimension, such as the possibility of developing new production models and/or examining developments in just one country (e.g., Lewis 2013). In this article, I take a position between these choices, identifying four major sub-systems, or political economies, that I argue are useful for not just understanding energy system dynamics (Hochstetler 2021a; Lockwood 2022) but also those of food systems. They are climate dimensions; production concerns; consumption concerns; and land-use dimensions (which also introduce non-climate environmental concerns). The choice of sub-systems is justified in part on their being major themes in existing literature, as well as the general separation of the topics – their relevant institutions, interests, and ideas - from each other in energy systems. While they have proven useful for studying energy transition, the final major section discusses whether they are likely to be equally useful for studying food transitions.

Each of these four, I argue, tends to form a largely separate political economy: that is, each is likely to view energy transition through a different conception of the basic structure of interests at the core of its major topic, is instantiated through different institutions in both state and society, and has different ideas about desirable endpoints of transition. Thus, the state and societal actors most engaged in developing national climate approaches and positions in international negotiations on climate change tend not to be the same state and societal actors promoting innovation and development of the energy production sector. The former tend to be environmental ministries and activists, while the latter are dominated by economic ministries and firms. Those in turn are different from the public utilities and consumer organizations prominent in providing electricity services to consumers. Finally, the particularly local and specific character of land-use issues bring a strong focus on community-level concerns, even as they are set within larger frameworks of land ownership and planning for its use. Questions about equity of outcomes and processes, the building blocks of a just transition, also appear differently in each.

The basic interest structure of the *climate change* political economy is notoriously stacked against easy action: there is a general, but diffuse, interest in addressing the greenhouse gas (GHG) emissions that cause climate change, with the strongest negative effects still in the future – even as they are coming closer to the present (Steffen, et al. 2015). With the atmosphere a global commons, climate change has long been understood as presenting a collective action problem (e.g., Keohane and Victor 2011). As a result, climate change continues to most-readily mobilize environmentally-oriented actors in state and society, like environmental ministries and movements, although far-sighted actors across the board are increasingly engaged, including financial and other economic actors. Notwithstanding this common presentation of the interests associated with climate change, scholars have noted that the topic has strong distributive dimensions as well (Äklin and Mildenberger 2021). In particular, really addressing climate change means that many current economic activities, notably in the fossil fuel and other emissions-dense sectors, must be halted. Not surprisingly, the powerful actors who have gained from these economic activities have responded with denial, resistance, and outright opposition to climate action (Brulle 2021; Hochstetler 2021a; Moe 2015). On the other hand, climate *in*action means heavy costs for some of the least powerful across and within nations, as do some forms of climate action (Prakash, et al. 2021; Smith and McNamara 2015).

The political economy of energy or food *production* tends to involve a narrower set of economically oriented actors. Here, the interest structure does include economy-wide concerns like economic growth and innovation and the jobs and other benefits that might come with them, but particular firms and economic sectors are at the centre of this political economy (Rodrik 2014). The general orientation is one of pursuing growth and expansion, so this political economy is more focused on positive incentives. How will this growth happen? In the area of energy transition, there is fairly general agreement that the growth of pro-transition firms and sectors will require support from government policies to encourage them. The energy sector writ large continues to have substantial state participation in many countries, in both ownership and regulations of private actors (Victor and Heller 2007). Traditional energy sources have often benefitted from decades of subsidies and supports, not least the ability to externalise environmental and other costs (Schlömer et al. 2014: 1332-1333; Stern 2007). They also are deeply embedded both politically and in the built infrastructure (Geels 2014). Thus, energy transition is seen to require supportive industrial policy for renewable energy, which in turn potentially provides many positive incentives for action that advances energy system transition. The implications for jobs and labour made the production political economy the place where "just transition" debates first emerged globally (Morena, Krause, and Stevis 2020). Below I discuss the extensive literature on this topic, while examining what parts might be relevant to the less-state-dominated food production sector.

In most countries, virtually everyone is a consumer of energy and food on a daily basis (not true for all complex systems), making the *consumption* political economy important to both, on a large scale. Where transition dynamics improve access to and quality of these goods, wide support coalitions may emerge. Utilities, distributors, and consumers form the core actors in this political economy, with the latter two also important for food systems. There is a universal and immediate interest in accessing an adequate quantity of these goods, with more complex interests in accessing an adequate quality, at acceptable costs, and more debates about what those entail (Brown and Mobarak 2009; Min 2015). In energy systems, government policy again is very important in most countries to set the precise arrangements of electricity consumption, creating strong secondary interest structures that may, for example, pit industry and household interests against each other or reinforce racial and ethnic divisions (Hochstetler 2021a: Chapter 4; Kramon and Posner 2013). These are especially likely when not all consumers have access to the energy they need, but there are complex subsidies and cross-subsidies in many countries. Individual consumption decisions evidently carry more weight in the food system, although they still make choices in a consumption marketplace that is often shaped by government regulations and subsidies of various kinds.

At the risk of stating the obvious, energy installations and agricultural production require land, including land that might have been or be used for other purposes. Thus land-use issues are central to both transitions, including historical land tenure structures and current regulations for land-use. Scholars have debated whether new land uses like a wind power farm represent opportunities or costs for local communities, with different disciplines indicating different starting assumptions (Hochstetler 2021a: Chapter 5). Economists and energy scholars tend to see economic opportunities for host communities (e.g., Brown, et al. 2012; Copena and Simón 2018; Xia and Song 2017), while anthropologists and geographers stress the possible human costs of land-use change and social disruption (Avila 2018; Brannstrom, et al. 2017; Ogilvie and Rootes 2015: 875). Some of the alternate uses are also environmental, setting up a "green versus green" dilemma in some cases, where the climate good of a renewable energy installation may conflict with environmental conservation of other species, for example (Yonk, Simmons, and Steed 2013: 2). This can create a structure of interests where a national and global good might incur concentrated local costs, or vice versa. Given all these observations, the structure of interests in this political economy is not as clear as it is for the others. Environmental actors are particularly important in this political economy because of the relevance of environmental impact assessments, but other land-use regulators and local communities also play a role, along with the firms developing projects.

Finally, while each of these political economies may operate in some isolation from the others, involving different interests and institutions, a final analysis needs to investigate how those distinct political economies intersect (Hochstetler 2021a: Chapter 6). Are they mutually reinforcing, with spillover of actors and ideas between them? For example, might decarbonisation actions and policies in fact motivate a series of cross-sectoral developments? Conversely, are the political economies in conflict with each other, such that climate policies and approaches for decarbonization are being actively undermined by actors and decisions in the area of production or another political economy? Which trade-offs need active management or cross-sectoral policy coordination?

The next four sections examine each of these political economies in more detail. As each is quite complex and deserves more extended treatment, the discussion here focuses just on a couple of key lessons that can be learned from the study of energy transitions for food transitions. The conclusions then reflect on the broader question of how the political economies interact and what can - and cannot - be learned about food systems transitions from the study of energy systems transitions.

Climate Change: Saying No to Sources of Greenhouse Gas Emissions, but Financing Transformation

In the 21st century, the phrase energy transition is largely understood to have decarbonization as its end point, with the replacement of fossil fuels by low-carbon renewable electricity like wind and solar power often standing as the primary marker of transition (see, e.g., Blazquez, Fuentes, Manzano 2020; Chang, et al. 2021). In contrast, the first pages of a Google Scholar search on "food systems transition" show considerably more variation in their topics, from a broader discussion of environmental issues beyond climate to topics like nutrition and food insecurity. Thus, a climate focus captures less of the desired transition(s) in food systems than in energy systems.

Dominant climate narratives and ideas often feature language of urgency and doomsday scenarios (Hinkel, et al. 2020; Steffen, et al. 2015). Within them, the framing of the exact endpoint of addressing climate change has changed in the more than three decades since global climate negotiations began in 1990. The current most popular version – "Net zero by 2050" or perhaps even earlier – leaves the ambition quite clear: addressing climate change means stopping activities that have been a central part of human activity for centuries now (Hess 2018: 178; Intergovernmental Panel on Climate Change 2021). Significant fossil fuel resources must not be developed and used, with implications for a multitude of everyday experiences and activities (Princen, Manno, and Martin 2015). This introduces a zero-sum logic to the climate political economy that the others do not have (Hochstetler 2021a: 30-31). This zero-sum logic exists both within countries and across them, complicating international agreements. What lessons can be learned from the experiences of energy actors and energy transition in the climate change political economy?

One of the most important lessons is that powerful actors, whose very power is built on their past gains from the activities that drive climate change, will mobilize to protect their interests. While much of the scholarly interest has focused on the proponents of climate action (e.g., Bulkeley, et al. 2014; Hadden 2015), scholars are now more thoroughly documenting the both open and covert opposition of key players. For example, Eskom, the monopoly electricity para-statal in South Africa, organized a substantial anti-transition coalition around it, with support from parts of the labour movement, the governing African National Congress, and – at first – large electricity users. It refused to develop renewable energy itself and moved to block private actors for a number of years (Hochstetler 2021a).

Utilities elsewhere have played similar roles (e.g., Stokes 2020). Similarly, fossil fuel companies seeded doubt and misinformation about the science of climate change, sometimes with the assistance of scientists and journalists, drawing on deep political connections to slow down policy developments in the area (Grasso 2019; Supran and Oreskes 2017). In short, climate debates are unavoidably political and cannot be easily resolved with common recommendations like technical fixes and better scientific communication. While a carbon price might send a clear message, these actors have often worked to block the mechanism altogether or to ensure the price is set so low to be ineffective or directed away from key emitters, as happened in South Africa (Rennkamp 2019).

This lesson from the energy transition holds in many individual countries and also spilled over into international negotiations. The Intergovernmental Panel on Climate Change (IPCC), responsible for reviewing scientific consensus on climate change for policy makers, has been particularly clear on the need for energy transition. It has stated that one of the fastest and most cost-efficient ways to reduce GHG emissions and prevent future climate change is to electrify as much as possible while shifting to non-fossil fuel sources of electricity, like wind and solar power (Intergovernmental Panel on Climate Change 2014a: 20). Even so, the fact that governments reached the Glasgow negotiation session in 2021 before they could bring themselves to even offer a halting call to stop fossil fuel production (UNFCCC 2021) shows the ongoing structural power of fossil fuel actors, as just described. The economic actors have often been joined in international opposition by governments that represent countries that are heavily dependent on fossil fuel production (Barnett 2008).

The unavoidable mandate to expect and prepare for vested interests to launch powerful political confrontations over climate action is likely to have direct parallels in the food systems transition, where power relations are in the backdrop at all times (Leach, et al. 2020). For example, the concentrated group of global food processors will have clear incentives to block policies and agreements to move away from the production and consumption of animal products, which the IPCC has identified as a growing driver of emissions (Howard 2016; IPCC 2014b: 822). Fossil fuels are embedded in large scale commercial agriculture, as Russia's invasion of Ukraine has shown to all, and the same oil and gas actors should be expected to try to block climate action in the agricultural sphere as well. Because of the existential nature of their interest in continued carbon emissions, there is limited scope with these actors for reworking ideas and narratives about climate change. Concerted global political agreements are probably necessary to restrain them. While anaemic to date for both energy and food systems (Clapp and Scott 2018: 4-5; Van de Graaf 2013), climate negotiations themselves have shown some dynamism in recent years while still being far from the decarbonization aim (Falkner 2016).

One of the most contentious topics in these climate negotiations, year after year, has been the finance that will be provided to developing countries both to help them reduce their GHG emissions (mitigation) and adjust to the climate change already baked into the present and future (adaptation) (Roberts, et al. 2021). These discussions have shaped the climate debates themselves as well as the support that might be offered for both energy and food systems transition. Developing countries, the source of many future GHG emissions, have explicitly conditioned the future actions in their Nationally Determined Contributions (NDCs) on the quantity and quality of climate finance they will receive (Leinaweaver and Thomson 2021). Those levels of finance have never met the $US100 billion per year by 2020 promised in Copenhagen in 2009. Perhaps even more damaging, there is significant debate about the accounting rules that would even establish the levels reached. In one particularly notorious debate, the OECD reported an annual average of $US57 billions of total public and private finance in 2013-2014, while the Indian Ministry of Finance recalculated the sum as only US$1-2.2 billions (Roberts, et al. 2021: 180).

While a great deal could be written about climate finance (and much has been), it is particularly noteworthy here that the pathologies of climate finance have been more favourable for supporting energy transition than they would be for supporting food systems transition. This does not mean that climate finance could not be mobilized for food systems transition, but that it would require additional work beyond simply increasing total climate finance. While there are as many as 100 channels of climate funding (Roberts, et al. 2021: 181), this discussion will focus on the unfolding of the Clean

Development Mechanism (CDM) associated with the 1997 Kyoto Protocol and the discussions of a successor agreement, as it shows the issues raised. The CDM was developed to respond to developing countries' demands for assistance for their then-voluntary climate action as well as the US government's insistence on including market mechanisms in the Kyoto Protocol (before it withdrew). CDM projects linked finance from developed countries to particular carbon-reducing initiatives in developing countries that would not have been done otherwise ("additionality"). Once the project was accepted and registered, the developed country could then claim Certified Emissions Reductions (CER) towards its own obligations to reduce its GHG emissions (an "offset").

Of the 5824 CDM projects approved by 2011, 964 (17%) of them were agriculture projects, while hydropower claimed 1558 projects (27%), alternative energy 1221 (21%), and energy efficiency 837 (14%), along with several smaller categories (Larson, Dinar, and Frisbie 2011: 33). This is a particularly broad counting of agriculture projects, defining them as "a project that uses agricultural residuals, outputs or agricultural projects to directly or indirectly reduce greenhouse gas emissions", while other counts are as low as just two projects (ibid: 4). In any event, most of the projects involve using agriculture as a source of bio-energy, not usually thought of as central to food systems transition, while the energy projects involve the kind of generation substitutions that are central to decarbonization. Very few projects aimed to substantially change how agricultural lands are used.

Why would renewable energy projects be so appealing? As already noted, such projects virtually define what it means to do a low-carbon transition in the energy sector (Chang, et al. 2021). As built infrastructure, they could be counted on to deliver easily measured carbon savings over an extended period ("permanence"). Host governments and economic actors were generally eager to welcome projects that expanded energy supply and security in developing countries where energy and especially electricity were scarce ("co-benefits"). In addition, the limits on state resources for energy investments and the comparatively high costs of especially the alternative renewables at the beginning of the 21st century made the additionality of these projects clear. These positive reasons for sending climate finance to projects that enhance energy transition are somewhat counter-balanced by the pernicious effects of narrowing the climate finance target to reducing carbon emissions and climate neutral growth, which leads in turn to heavily emphasizing particular agreed and easily measurable activities. Veelen (2021), for example, reports of green finance issued by a dairy company that was used to purchase renewable energy for its processing plant, which generates just a fraction of the untouched GHG emissions of its farm emissions. Similarly, Brazil's rapid expansion of its wind power capacity sits in energy planning documents right next to its plans for expanding oil and gas production in its pre-salt region (Hochstetler 2021a: 72-74). Multiplying individual renewable energy projects, even ones with few GHG emissions, do not guarantee a broader systemic transition.

The tendency for climate finance to follow easy routes to typical projects that are easily explained to investors and carbon exchanges poses potential challenges for deepening green investments in agriculture. Agricultural practices do offer many opportunities for climate-friendly improvements, including offering possible co-benefits (but also adverse impacts) for other food systems goals (Smith, et al. 2007: 8-9). Changes that would sequester carbon in soils, for example, "often leads to increased production and greater economic returns", requiring just knowledge and information in many cases (Conant 2011: 243). Those same characteristics lead to one of the typical barriers to directing climate finance to agricultural projects, which is that it can be hard to show the additionality required by many carbon credit processes, as the changes would arguably have been done anyway (Conant 2011: 245; Smith, et al. 2007: 8). Other problems are more specific to agricultural changes, such as that it is more difficult for them to establish the permanence of the changes; sequestered carbon can be readily released when practices are reversed (Conant 2011: 245). In addition, there is the potential problem of "leakage", even more prominent for conserved forests, where degradation or emissions are simply displaced to another location as one is protected (ibid). Similar problems are present for forest-related GHG emissions, and states have eventually worked out a set of processes in REDD+ (Voigt and Ferreira 2015). But, generally, in a world of limited climate finance, the policy and technological constraints on climate finance in agriculture have sent funds elsewhere so those would need to be tackled to move climate finance to food systems change (Smith, et al. 2007).

As a final point on the CDM projects, 2316 were based on China (40%), 1549 in India (27%), and 365 in Brazil (6%) (Larson, et al 2021: 39-40). Most other countries had fewer than 5 projects, with nearly 100 having none. This often-remarked inequality reflects the inequity of global economic investments more generally as well as the specific complexities of managing CDM projects, which were beyond the administrative capacities of many countries.

Production: Opportunities for Innovation and Sectoral Development

The climate change agenda for energy systems transition stresses the need to shut down fossil fuels, with predictable political and economic dilemmas, as we have just seen. In contrast, the production agenda for energy systems transition is largely a positive agenda about economic expansion and growth. Both academics and policy makers have proclaimed the ways that the production side of the energy sector can contribute to energy transition, achieving both important sectoral development goals and possibly wider societal economic goals as well. Renewable energy, including wind and solar powered electricity and various biofuels, have been at the centre of these claims. Since the global financial crisis of 2008, these alternative energy sources have been hailed as a source of high-quality jobs, potential for innovation, and an engine for broader economic growth – even as they help address climate change (Hess 2012; Rodrik 2014). By 2015, 164 countries had some kind of renewable energy target (International Renewable Energy Association 2016: 8), often citing these reasons. In short, the narratives around the production political economy in the energy sector are often ideas about opportunities for growth and innovation, in addition to jobs. It is worth noting that while the emphasis is often on the specialized technical jobs, a recent estimate by the Australian Clean Energy Council concludes that "just under half the clean energy workforce is in non-engineering fields, including finance, business, law, IT, sales, agriculture, safety, training, communications, and community engagement" (Clean Energy Council 2022). To the extent that these promises are fulfilled, the production side of energy transition can provide powerful co-benefits of climate action. This section further develops and evaluates several claims for the pro-transition production in the energy sector before evaluating how they might appear and be promoted in food systems transition.

"Good green jobs in a global economy": this title of a book about renewable energy industry development in the United States (Hess 2012) reflects one of the most common framings of energy transition for both academics and policy makers. Key interpretive frameworks, like that of the socio-technical transition (Geels 2002; Geels 2004), stress the driving forces of technological change and innovation in creating a wider and deeper transformation in the energy system and even beyond (see also Gallagher 2014; Lester and Hart 2012; Lewis 2013; Nahm 2021; Zysman and Huberty 2014). European early movers like Denmark and Germany showed how these changes could happen, over a time frame that now seems quite leisurely. More recently, the supply chains and dynamics of technological change have globalized, resulting in a fast-developing sector that is very different from that of the early adopters (Gallagher 2014; Meckling and Hughes 2017). In this context, the bigger developing countries have moved to claim their own place, with China surging to leadership (Lewis 2013), while the others – and the smaller developing countries following them in turn – are facing more mixed outcomes. Whatever the outcomes, the attraction of building new growth sectors, luring new investment, and finding those good green jobs in a global economy was a very powerful motivation for Brazil and South Africa to begin to develop the new renewables (Hochstetler 2021a). The surge of wind power in Brazil after 2009 while solar power lagged owes a great deal to the easier path to related industrial development in Brazil for wind power (ibid: 129).

A closely related topic is the finance and investment that might support this growth. Finance for energy transition comes from many sources, from the special climate funds already discussed to traditional bank finance. In addition, the Brazilian and South African processes of developing renewable energy drew on funds from their national development banks. These resources were significant for Brazilian wind power – a bit less than half of auction-winning projects (Hochstetler 2021a: 96) – although less for the others. Both countries used their national funds to channel the investments to particular national priorities. In the case of the Brazilian National Development Bank, BNDES, use of its funds came with its historic requirement for local content, with the bank eventually developing a stepped system that financed a larger percentage of project costs with larger shares of local content and more advanced technology (Ferreira 2017). Some of the funds it used in turn came from its first Green Bonds issued. In the South African case, the Development Bank of Southern Africa, DBSA, funded the non-price components of its auction system, notably a series of requirements for community ownership, Black South African and local labour, and other requirements to provide local benefits (Tait, Wlokas, and Garfield 2013). In this way, the national development banks were important for ensuring that the particular co-benefits desired by national actors were delivered.

Brazil and South Africa also offer something of a cautionary tale for countries that might want to start this path now. Many of the most-attractive economic benefits come from developing a local manufacturing industry, with installation and operations and maintenance offering far less in the way of jobs and broader developments. Localisation has happened only in the Brazilian wind power sector so far, and only through significant state support and with too few jobs to impress its trade unions (Hochstetler 2021a: 102-103). India also struggled to develop a domestic solar industry given little industry support and limited demand, raising concerns about a "green division of labour, with most of the Global South locked in dependency on American, European, and East Asian technologies" (Behuria 2020). If these large regional powers with significant manufacturing capacity have not gained much of a foothold, others will be even less able to do so in the face of the newly globalized industry in a more mature market. Since 2010, countries have been increasingly willing to defend their firms' market positions at the WTO as well (Lewis 2014).

Possible innovations and industry development are important in their own right. They have contributed to a rapid fall in the prices of alternative forms of energy, even as the efficacy and size of installations have grown. This has been quite important in the next political economy, on consumption. However, the political repercussions may be even more important. The possibility of sector-driven economic growth and development is a powerful attractor for policy makers, appearing as a co-benefit of action that is also good for climate change. In addition, the actors in the sector have become a sustaining part of a pro-transition coalition, contributing to a "'green spiral' – a process of policy feedback in which initial incremental steps to jointly address economic and environmental issues might over time build up industrial coalitions with material interests in favor of sustaining and expanding efforts at climate change mitigation" (Kelsey and Zysman 2014: 79; Meckling, et al. 2015). This is also the instinct at the heart of recent calls for a Green New Deal, where a whole series of cognate decisions in other domains lead additional actors to support energy transition and climate action (Aronoff, Battistoni, Cohen, and Riofrancos 2019; Pettifor 2019; Stokes 2020). It has been less noted that this kind of effort to broaden the political coalition behind change may also lead to a wider negative backlash if the promised benefits do not appear. This was part of the dynamic that turned the South African labour movement against the country's renewable energy policy, as jobs seemed more certain and attainable in coal than in wind and solar power (Hochstetler 2021a: 124-125). The idea of a just transition originated in the global labour movement and reflects this need to consider who is left behind by energy transition and how they might be compensated (Stevis and Felli 2015).

Food systems contain similar preoccupations with the production sphere. The traditional Malthusian concern with feeding a growing population will now be made more difficult by growing complications from climate change (Béné 2019: 118; Leach, et al. 2020: 2). Technological, social, and institutional innovations are as necessary to drive transformations in the food system as they are in the energy system. There is a significant challenge in the food system in getting production-related growth and innovation to be oriented in the right direction (Dinesh, et al. 2021: 2), as that is less obvious than the energy system's simple imperative to produce more energy based on non-fossil fuels. Many historical agricultural innovations may have increased production, but with significant costs for other political economies. The costs may be visible only years later. For example, Brazil's Enterprise for Agricultural Research (EMBRAPA) developed technologies to improve soil chemistry and introduce new varieties of *rhizobium*; with other technical solutions like no-till production, these innovations opened up whole areas of "wasteland" to agriculture (Hopewell 2016: 544). Over the next couple of decades, that opening made large parts of the Amazon and Cerrado ecosystems attractive for deforestation for agricultural purposes, Brazil's largest contributor to GHG emissions (Hochstetler 2021b). The idea of Climate Smart Agriculture would aim to avoid such developments, although may still leave out whole transformation agendas like land tenure rights as agricultural lands expand (Chandra, McNamara, and Dargusch 2018; Clapp, Newell, and Brent 2018).

Another area where the energy system may offer possible lessons for the food system is in considering the debates among energy systems scholars and policy makers about how and when governments can contribute to positive outcomes. This debate reflects the strong roles that states have often played in the energy sector, whether it is the national oil companies in the petroleum and gas sector (Victor, Hults, and Thurber 2011) or the historical state dominance of the electricity sector (Victor and Heller 2007). In addition, incumbent fuels and actors often have locked in their role through both physical infrastructures and complex economic and political arrangements, so that energy transition is thought to require the extra impulse of state action to induce change (Hochstetler 2021a; Unruh 2000). At the same time, early developments and innovations were often in the hands of individual firms and even non-governmental actors and local communities, albeit often in response to national policies and institutions (Morris and Jungjohann 2016; Nahm 2021). Whether or not some version of green industrial policy is *needed* to develop more renewable energy production (Rodrik 2014), in practice, governments around the world have offered the industry special finance, tax and regulatory breaks, and other incentives to expand (Lewis 2021; Nahm 2021; Pegels 2014a; Zysman and Huberty 2014). Both national and international climate finance have been especially important motivators, where present. Simple demand for renewable energy in national electricity grids has also been an important motivator for localisation of industry (Hochstetler 2021a: Chapter 3).

In this research, it is clear that the governmental incentives through industrial policy have changed the pace and the form of the energy transition. Whether they have always done so in a sustainable and effective fashion brings questions of rent management and political capture to the front of the production political economy of energy transition (Aggarwal and Evenett 2012; Pegels 2014a; Zysman and Huberty 2014). Scholars have argued that the distortions and privileges of the fossil fuel economy require the intervention in general terms (Rodrik 2014). Yet specific management systems matter crucially for the outcomes. Writing about the experiences of developing countries, Anna Pegels stresses the need for including competition where possible, finding a balance between flexible adjustments and investment certainty, responding to national conditions while learning from others, and building social and political support – something the industrial policy itself can enhance, as above (Pegels 2014b: 184). Significant state capacity is necessary to do this well. States have historically played a smaller role in production in the food system, but many provide some form of credit and other subsidies to the sector and may provide other incentives meant to shape the direction of change. As such, many of the conclusions here seem directly relevant for food systems transition.

Consumption: Balancing Price and Quality

In the consumption political economy, the noted difference in state roles between the energy and food systems is even more relevant. In most countries, governments continue to directly control or closely regulate the distribution of electricity and some other forms of energy to consumers, while consumption in food systems is much more likely to be in the control of individual consumers, even as their choices are guided by regulatory and subsidy systems. Thus, while both of these systems enter into the daily consumption routines of essentially all humans and the larger economy, they do so very differently and there are fewer lessons to be drawn from one to the other. However, in both cases at least some of the proposed changes offer possible positive opportunities to consumers, and so could provide additional incentives for movement in the direction of system transition, although others may be less promising.

As described above, the consumption political economy for energy reflects a nearly universal need for some kinds of energy with which to cook, light, and transit, as well as more complex economic activities. At one level, the interests involved are simple: "No one prefers fewer hours of electricity, less reliable supply, or higher rates" (Min 2015: 6-7), but the details of the consumption arrangements can matter a great deal. In addition, many developing countries find that they face significant trade-offs between cost versus access and quality issues. For example, higher electricity rates may allow cross-subsidization that brings new, poorer customers onto the electricity grid, but will reduce their participation if there is no cross-subsidization. The fact that costs to consumers are also revenues to the utilities that are responsible for building and maintaining supply is at the heart of this contradiction.

One of the most direct impacts of energy systems transition on the consumption political economy has been through the changing costs of alternative sources of energy. For several decades during the modern expansion of renewable energy, the comparatively – if not prohibitively – high costs of wind and solar power made them options only for countries willing and able to pay the premium. Not surprisingly, these were mostly advanced industrial economies and even there the costs were hotly debated (Äklin and Urpelainen 2018: 7). As prices began to drop sharply in the second decade of the 2000s, enthusiasm for renewables grew (ibid: 193-194). The boost to demand from climate commitments (see above), the entrance of lower-cost manufacturers like China (Lewis 2013), numerous technological innovations that were more widely shared (Gallagher 2014), and the wider use of procurement mechanisms like auctions that used competition to reduce prices (International Renewable Energy Agency 2017: 3) all were factors here. In just the four years from 2011 to 2015 separating the first and fourth auction rounds in South Africa, for example, winning solar power bids fell by 83 percent while wind power bids dropped by 59 percent. By 2015, they both cost R0.62/kWh versus the R1.03/kWh of new coal build (Bischof-Niemtz and Creamer 2019: 45). This is an example of the ways that the different political economies can coincide in cascading ways, with the lower prices further consolidating the other gains.[1]

Solar power is also hailed for its unique flexibility in scale, including a household scale that enables serving electricity consumers who are in remote locations or who prefer self-provision (Garcez 2015: 18; Sovacool and Drupady 2012: 1, 6). In practice, there are two quite different distributive scenarios that can result. The first is the one most commonly presented, where under-served consumers gain access to the grid where they did not have it before (Brass, et al. 2012: 108-109). This has the potential to democratize this important service (Abromovay 2014; Burke and Stephens 2018). The quality of the resulting service is debated, especially for the low-cost systems usually offered to these consumers (e.g., Monyei, Adewumi, and Jenkins 2018; Slough, Urpelainen, and Yang 2015). Conversely, wealthier consumers may opt off the grid for private solar electricity provision, in much the same way that they prefer to procure their own private education, security, health and other services rather than rely on poor-quality public services (Abromovay 2014; Hochstetler 2021: 137-138). Even in wealthy countries, this carries the threat of a "utility death spiral" as fewer paying consumers are left to carry the grid (Castaneda, Franco, and Dyner 2017).

None of these developments have precise analogues in the global food system, nor do they necessarily extend from electricity to other parts of the energy system. Instead, they contribute to a more general alert about the need to pay attention to both the intersection of consumption issues with other political economies and the trade-offs that frequently appear in the consumption sphere itself. In the food system, the trade-off between cost and nutritional quality of food is frequently noted (Béné, at al. 2019), for example.

Land-use Issues: Climate and other Environmental and Social Impacts of Transition Locally

In land-use issues, there are more parallels between the two systems and the issues that arise. Not all large global systems have the land impacts that these do. In fact, energy transition itself exacerbates land-use conflict, as wind and solar power are lower than fossil fuels in energy density per land unit (Scheidel and Sorman 2012). In addition, inputs now heavily demanded for renewable energy generation and storage may put new pressures on mining communities (e.g., Barandiaran 2019). Food systems transition may involve either expanding or intensifying agricultural land use, but both involve land-use change with significant potential impacts (Kremen 2015). Some of the impacts

[1] It is worth noting that in some cases like Brazilian solar power, however, the desire to build a domestic industry actually delayed deployment and raised the cost of solar power components (Hochstetler 2021a) so the spillovers are not all positive.

of transition are environmental, potentially raising the “green vs. green” dilemma (Yonk, et al. 2013), where changes that improve climate outcomes may carry negative consequences for biodiversity, water quality, or other environmental issues. Other impacts are social, with both systems involving significant ideational debates over the desirable scale of developments, with counter-poised preferences for large versus small installations (Clapp and Scott 2018: 3-4; Morris and Jungjohann 2016). Any land-use changes are typically layered onto existing land tenure systems, often at the root of national inequalities.

Climate change concerns drive many discussions about the need for major systemic transformations and proponents of action on other environmental topics frequently try to link to climate change in order to gain more attention and seek common solutions. Yet one lesson of energy transition is that changes that advance climate solutions – like the development of wind and solar power – are not necessarily beneficial for other environmental purposes. In a number of locations, local and environmental opposition is built around the negative impacts of wind power in particular on birds, bats, and other species (Yonk, et al. 2013). The environmental and social harms of the supply chains of renewable energy are also becoming increasingly clear (Sovacool, et al. 2020).[2] These impacts of transition cannot be denied or wished away – not least because the host communities often will not allow them to be. At the same time researchers and policy makers should actively listen to those communities since they are not all experiencing or saying the same things. A project-level analysis of Brazil’s 600 wind farms, for example, found community opposition in one quarter of the host communities. It most often appeared in communities that had historically insecure land claims, like the *quilombolas*, or former slave communities. Conversely, strong resistance to wind power appeared in only one South African community, a middle-class urban community (Hochstetler 2021a: Chapter 5). In both cases, there was some ability to adjust sites of projects to reduce conflict – and the underlying negative environmental and social impacts. However, sometimes the multiple environmental and social aims do conflict and require attention to the balance that must be sought.

Behind some of these conflicts is a background ideational debate about the desirable scale of energy projects that has clear parallels in the food systems debates. In the early stages of modern renewable energy development, many wind farms were small and owned and operated by local communities (Morris and Jungjohann 2016). Generous feed-in tariffs allowed these projects to thrive, generating direct economic benefits for their host communities; little opposition arose as a result. That model has been dramatically altered as the transition advanced, so that modal wind farms today include large numbers of very large turbines, often built and operated by multi-national firms. Solar power too is now fully integrated into global supply chains and built on a large scale (Meckling and Hughes 2017). A critical turning point was the introduction of competitive auctions for procurement, whose price orientation drove a new focus on low-cost and efficient production (IRENA 2017). This same turning point was a positive turn in the previous political economy as one of the factors driving down the prices of renewable energy and welcomed by those looking for a large scale and rapid transition in the energy system. That vision is countered by regrets about the loss of a small-scale and more democratic kind of self-provision of electricity, where a model that provides just the electricity, cheaply, is seen as a loss rather than a gain to meaningful energy transition (Swilling 2020). There is a similar ideational debate in the study of agriculture and food systems, between whether transformation is best achieved on a small or large scale (Clapp and Scott 2018: 3-4). As it is an ideational debate, the point is less to assert that one is right and the other wrong, and more to note the presence of these competing visions in both systems about the right way to reach a desirable endpoint. Still, in this context, one can draw out the observation that the presence of community resistance correlates with the size of the project (Hochstetler and Tranjan 2016).

While far from comprehensive, these examples show the complexity and importance of land-use issues to both of these global systems and possible transformations of them. Changes that follow the

[2] It should be noted that traditional sources of energy also have severe impacts on the environment and local communities (Acselrad and Mello 2010; Sawyer 2004).

aims of the other political economies may well have negative consequences for the political economy of land-use, with particular costs for those populations that are already economically and socially marginal because of their informal and unreliable land-use rights. Ignoring these issues may bring not only direct opposition from the communities affected by the transitions, but also ideational opposition from those whose vision of a just and compelling transitional endpoint looks for a smaller and – they would say, more human – scale of a new energy or food system.

From Energy Transition to Food Transitions? Notes on the Comparison as Conclusion

Energy systems and food systems share certain features that make them more comparable than some paired systems might be. Both have potentially large-scale land-use implications and an associated debate about the desirable scale for a transition. Both are part of everyday consumption for most people, giving them a reach and importance that few other - even global – systems can muster. In part for that reason, political elites have a great deal of interest in production in the sector, offering both incentives and regulations to reach desired ends. Finally, each sector has a large impact on global greenhouse gas emissions, and so transformations in the spheres are likely to shape which climate change outcomes are possible. Both have many positive impulses for change as well as both a problematic status quo and other dynamics of change that would further worsen their impacts. On the basis of these similarities, this paper has sought to identify lessons that can be learned from the energy transitions literature for food systems transition.

Before concluding with those lessons, it is useful to consider two large areas of dissimilarity between the two. As has been noted several times, the state role in the energy system, and especially in the electricity sector seen as key to decarbonization, is historically large, even where privatization has taken place. In contrast, the food system, while subject to state regulation and shaping, is more driven by more-or-less open markets and individual production and consumption decisions. Thus, some of the tools of transition are more familiar and broadly used in the energy system than they are in the food system. This is particularly visible in the national and international finance offered in support of energy transition.

Another difference is that the understanding of energy systems transition places climate change in a very central position, with decarbonization the presumed aim of the transition. In contrast, the understanding of food systems transition seems less agreed on the desired outcomes of transition. Climate is not even necessarily the main environmental focus, with a broader range of sustainability issues like biodiversity and water and soil quality seen as additional important metrics of transformation. Non-environmental aims like improving nutrition and diet also take centre place. This draws attention to the occasional over-narrowness of the energy transitions debate, where a close focus on reducing GHG emissions and building more renewable energy may eclipse a broader understanding of the transitions necessary. The energy transition literature has often overlooked the non-climate environmental impacts of expanding non-fossil fuel forms of energy, for example.

Returning now to the shared conclusions, the study of both systems transitions benefits from a multi-faceted look at multiple political economies within the larger overall transition. The relevant interests, institutions, and ideas may vary a great deal from one sub-system to another, and it is valuable to trace the dynamics of those sub-systems individually inside the larger process of change. This will draw attention to the fact that the smaller political economies may not all be evolving at the same pace and may even be developing in incompatible ways. The approach draws attention to potential real trade-offs that must be considered.

At the same time, a broader argument is made about the ways that the climate change political economy may interact with the others in both transitions. Narratives about climate change are often gloomy and stress the costs of both current action and future climate change. The difficult climate future is seen to require current action that almost inherently requires taking on very powerful actors who have benefitted historically from exploiting fossil fuels. Not surprisingly, they have fought to protect their positions and even to block the transition from unfolding. In contrast, the consumption and production political economies in particular offer more promising narratives and the possibility of compensations for making the changes that reduce the use of fossil fuels. New industries might develop, bringing jobs, innovation, and economic growth in their wake. Consumers are offered new alternatives for consumption, from access to electricity in remote locations to locally grown produce. Important in their own right, these offerings also broaden the political coalitions that might support deeper changes by increasing the numbers of people who have a stake in a successful transition. They can address the justice claims of those harmed by climate action. The energy transition has advanced by developing and proclaiming these possibilities and those interested in food systems transitions can learn a great deal from their experiences.

Abromovay, Ricardo. 2014. Innovations to Democratize Energy Access without Boosting Emissions. *Ambiente e Sociedade* 17(3): 1-18.
Acselrad, Henri and Cecília C. do A. Mello. 2010. Conflito Social e Risco Ambiental: O Caso de um Vazamento de Óleo na Baía de Guanabara. *Ecología Política. Naturaleza, Sociedad y Utopía*.
Aggarwal, Vinod K. and Simon J. Evenett. 2012. Industrial Policy Choice During the Crisis Era. *Oxford Review of Economic Policy* 28(2): 261-283.
Äklin, Michael and Matto Mildenberger. 2021. Prisoners of the Wrong Dilemma: Why Distributive Conflict, Not Collective Action, Characterizes the Politics of Climate Change. *Global Environmental Politics* 20(4): 4-27.
Aronoff, Kate, Alyssa Battistoni, Daniel Aldana Cohen, and Thea Riofrancos. 2019. *A Planet to Win: Why we Need a Green New Deal*. London and New York: Verso.
Avila, Sofia. 2018. Environmental Justice and the Expanding Geography of Wind Power Conflicts. *Sustainability Science* 13: 599-616.
Barandiarian, Javiera. 2019. Lithium and Development Imaginaries in Chile, Argentina and Bolivia. *World Development* 113(1): 381-391.
Barnett, Jon. 2008. The Worst of Friends: OPEC and G-77 in the Climate Regime. *Global Environmental Politics* 8(4): 1-8.
Behuria, Pritish. 2020. The Politics of Late Late Development in Renewable Energy Sectors: Dependency and Contradictory Tensions in India's National Solar Mission. *World Development* 126: 104726.
Béné, Christophe, Peter Oosterveer, Lea Lamotte, Inge D. Brouwer, Stef de Haan, Steve D. Prager, Elise F. Talsma, and Colin K. Khoury. 2019. When Food Systems Meet Sustainability – Current Narratives and Implications for Action. *World Development* 113: 116-130.
Blazquez, Jorge, Rolando Fuentes, Baltasar Manzano. 2020. On Some Economic Principles of the Energy Transition." *Energy Policy* 147: 111807.
Brannstrom, Christian, Adryane Gorayeb, Jocicléa de Souza Mendes, Caroline Loureiro, Antonio Jeovah de Andrade Meireles, Edson Vicente da Silva, Ana Larissa Ribeiro de Freitas, and Rafael Fialho de Oliveira. 2017. Is Brazilian Wind Power Development Sustainable? Insights from a Review of Conflicts in Ceará State. *Renewable and Sustainable Energy Reviews* 67:62-71.
Brass, Jennifer N., Sanya Carley, Lauren M. McLean, and Elizabeth Baldwin. 2012. Power for Development: A Review of Distributed Power Generation Projects in the Developing World. *Annual Review of Environment and Resources* 37:107-136.
Brown, David S. and Ahmed Mushfiq Mobarak. 2009. The Transforming Power of Democracy: Regime Type and the Distribution of Electricity. *American Political Science Review* 103(2): 193-213.
Brown, Jason P., John Pender, Ryan Wiser, Eric Lantz, and Ben Hoen. 2012. Ex Post Analysis of Economic Impacts from Wind Power Development in U.S. Counties. *Energy Economics* 34: 1743-1754.
Brulle, Robert J. 2019. Networks of opposition: a structural analysis of US climate change countermovement coalitions 1989–2015. *Sociological Inquiry* 91(3): 603-624.
Bulkeley, Harriet, Liliana B. Andonova, Michele M. Betsill, Daniel Compagnon, Thomas Hale, Matthew P. Hoffman, Peter Newell, Matthew Paterson, Charles Roger, and Stacy D. Vandeveer. 2014. *Transnational Climate Governance*. Cambridge: Cambridge University Press.
Burke, Matthew J. and Jennie C. Stephens. 2018. Political Power and Renewable Energy Futures: A Critical Review. *Energy Research and Social Sciences* 35:78-93.
Castaneda, Monica, Carlos J. Franco, and Isaac Dyner. 2017. Evaluating the Effect of Technology Transformation in the Electricity Utility Industry. *Renewable and Sustainable Energy Reviews* 80:341-351.
Chandra, Alvin, Karen E. McNamara, and Paul Dargusch. 2018. Climate-Smart Agriculture: Perspectives and Framings. *Climate Policy* 18(4): 526-541.
Chang, Miguel, Jacob Zink Thellufsen, Behnam Zakeri, Bryn Pickering, Stefan Pfenniger, Henrik Lund, and Paul Alberg Østergaard. 2021. Trends in Tools and Approaches for Modelling the Energy Transition. *Applied Energy* 290: 116731.

Clapp, Jennifer, Peter Newell, and Zoe W. Brent. 2018. Forum on Climate Smart Agriculture: The Global Political Economy of Climate Change, Agriculture and Food Systems. *Journal of Peasant Studies* 45(1): 80-88.
Clapp, Jennifer and Caitlin Scott. 2018. The Global Environmental Politics of Food. *Global Environmental Politics* 18(2): 1-11.
Clean Energy Council. 2022. Skilling the Energy Transition. Online at https://assets.cleanenergycouncil.org.au/documents/CEC_Skilling-the-Energy-Transition-2022.pdf.
Conant, Richard T. 2011. Sequestration Through Forestry and Agriculture. *WIRES Climate Change* 2(March): 238-254.
Copena, Damián and Xavier Simón. 2018. Wind Farms and Payments to Landowners: Opportunities for Rural Development for the Case of Galicia. *Renewable and Sustainable Energy Reviews* 95:38-47.
Davenport, Coral and Lisa Friedman. 2022. Five Decades in the Making: Why it Took Congress so Long to Act on Climate. *New York Times* 7 August 2022. Online at https://www.nytimes.com/2022/08/07/climate/senate-climate-law.html?referringSource=articleShare.
Dinesh, Dhanush, Dries L.T. Hegger, Laurens Klerkx, Joost Vervoort, Bruce M. Campbell, and Peter P.J. Driessen. 2021. Enacting Theories of Change for Food Systems Transformation Under Climate Change. *Global Food Security* 31: 100583.
Falkner, Robert. The Paris Agreement and the New Logic of International Climate Politics. *International Affairs* 92(5): 1107-1125.
Ferreira, Wilinton Conte. 2017. *Política de Conteúdo Local e Energia Eólica: A Experiência Brasileira*. PhD Dissertation, Universidade Federal Fluminense, Centro de Estudos Sociais Aplicados, Faculdade de Economia.
Gallagher, Kelly Sims. 2014. *The Globalization of Clean Energy Technology: Lessons from China*. Cambridge: MIT Press.
Garcez, Catherine Aliana Gucciardi. 2015. Políticas de Geração Distribuida e Sustentabilidade do Sistema Elétrico. PhD Dissertation, Universidade de Brasília, Centro de Desenvolvimento Sustentável.
Geels, Frank W. 2014. Regime Resistance Against Low-Carbon Transitions: Introducing Politics and Power into the Multi-level Perspective. *Culture & Society* 31(5): 21-40.
Geels, Frank W. 2004. From Sectoral Systems of Innovation to Socio-Technical Systems: Insights about Dynamics and Change from Sociology and Institutional Theory. *Research Policy* 33(6-7):897-920.
Geels, Frank W. 2002. Technological Transitions as Evolutionary Reconfiguration Processes. A Multi-level Perspective and a Case Study. *Research Policy* 31(8-9): 1257-1274.
Grashof, Katherina. 2019. Are Auctions Likely to Deter Community Wind Projects? And Would This be Problematic? *Energy Policy* 125: 20-32.
Grasso, Marco. 2019. Oily Politics: A Critical Assessment of the Oil and Gas Industry's Contribution to Climate Change. *Energy Research & Social Science* 50: 106-115.
Hadden, Jennifer. 2015. *Networks in Contention: The Divisive Politics of Climate Change*. Cambridge: Cambridge University Press.
Hess, David J. 2018. Energy Democracy and Social Movements: A Multi-coalition Perspective on the Politics of Sustainability Transitions. *Energy Research and Social Science* 40: 177-189.
Hess, David J. 2012. *Good Green Jobs in a Global Economy: Making and Keeping New Industries in the United States*. Cambridge: MIT Press.
Hinkel, Jochen, Diana Mangalagiu, Alexander Bisaro, and J. David Tàbara. 2020. Transformative Narratives for Climate Action. *Climatic Change* 160: 495-506.
Hochstetler, Kathryn. 2021a. *Political Economies of Energy Transition: Wind and Solar Power in Brazil and South Africa*. Cambridge: Cambridge University Press.
Hochstetler, Kathryn. 2021b. Climate Institutions in Brazil: Three Decades of Building and Dismantling Climate Capacity. *Environmental Politics* 30(sup 1): 49-70.
Hochstetler, Kathryn and J. Ricardo Tranjan. 2016. Environment and Consultation in the Brazilian Democratic Developmental State. *Comparative Politics* 48(4): 497-516.

Hopewell, Kristen. 2016. The Accidental Agro-Power: Constructing Comparative Advantage in Brazil. *New Political Economy* 21(6): 536-554.
Howard, Philip. 2016. *Concentration and Power in the Food System: Who Controls What We Eat?* London: Bloomsbury Publishing.
Intergovernmental Panel on Climate Change. 2014b. AR5 Climate Change 2014: Mitigation of Climate Change. Online at https://www.ipcc.ch/report/ar5/wg3/.
International Renewable Energy Agency. 2017. *Renewable Energy Auctions: Analysing 2016 Executive Summary*. Online at https://www.irena.org/publications/2017/Jan/Renewable-Energy-Auctions-Analysing-2016--executive-summary.
International Renewable Energy Agency. 2016. IRENA 2014-2015: At a Glance. Online at https://www.irena.org/publications/2016/Jan/IRENA-2014-2015-At-A-Glance.
Kashwan, Prakash, Frank Biermann, Aarti Gupta, and Chukwumerije Okereke. 2020. Planetary Justice: Prioritizing the Poor in Earth System Governance. *Earth System Governance* 6: 100075.
Kelsey, Nina and John Zysman. 2014. The Green Spiral. In *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*, eds. J, Zysman and M. Huberty. Stanford: Stanford Business Books.
Keohane, Robert and David G. Victor. 2011. The regime complex for climate change. *Perspectives on Politics* 9(1): 7-23.
Kramon, Eric and Daniel N. Posner. 2013. Who Benefits from Distributive Politics? How the Outcome One Studies Affects the Answer One Gets. *Perspectives on Politics* 11(2): 461-474.
Kremen, Claire. 2015. Reframing the Land-Sparing/Land-Sharing Debate for Biodiversity Conservation. *Annals of the New York Academy of Sciences* 1355(1): 52-76.
Larson, Donald F., Ariel Dinar, and J. Aapris Frisbie. 2011. Agriculture and the Clean Development Mechanism. World Bank, Policy Research Working Paper 5621, April 2011.
Leach, Melissa, Nicholas Nisbett, Lídia Cabral, Jody Harris, Naomi Hossain, John Thompson. 2020. Food Politics and Development. *World Development* 134: 105024.
Leinaweaver, Justin and Robert Thomson. 2021. The Elusive Governance of Climate Change: Nationally Determined Contributions as Commitments and Negotiating Positions. *Global Environmental Politics* 21(2): 73-98.
Lester, Richard K. and David M. Hart. 2012. *Unlocking Energy Innovation: How America Can Build a Low-Cost, Low-Carbon Energy System*. Cambridge: The MIT Press.
Lewis, Joanna I. 2021. Green Industrial Policy After Paris: Renewable Energy Policy Measures and Climate Goals. *Global Environmental Politics* 21(4): 42-63.
Lewis, Joanna I. 2014. The Rise of Renewable Energy Protectionism: Emerging Trade Conflicts and Implications for Low-Carbon Development. *Global Environmental Politics* 14(4): 10-35.
Lewis, Joanna I. 2013. *Green Innovation in China: China's Wind Power Industry and the Global Transition to a Low-Carbon Economy*. New York: Columbia University Press.
Lockwood, Matthew. 2022. Policy Feedback and Institutional Context in Energy Transitions. *Policy Sciences* https://doi.org/10.1007/s11077-022-09467-1.
Meadows, Donella H., edited by Diana Wright. 2008. *Thinking in Systems: A Primer*. Vermont: Chelsea Green Publishing.
Meckling, Jonas and Llewelyn Hughes. 2017. Globalizing Solar: Global Supply Chains and Trade Preferences. *International Studies Quarterly* 61(2): 225-235.
Meckling, Jonas, Nina Kelsey, Eric Biber, and John Zysman. 2015. Winning Coalitions for Climate Policy: Green Industrial Policy Builds Support for Carbon Regulations (Perspectives). *Science* 349(6253): 1170-1171.
Min, Brian. 2015. *Power and the Vote: Elections and Electricity in the Developing World*. Cambridge: Cambridge University Press.
Moe, Espen. 2015. *Renewable Energy Transformation or Fossil Fuels Backlash: Vested Interests in the Political Economy*. London: Palgrave McMillan.
Monyei, C.G., A.O. Adewumi, and K.E.H. Jenkins. 2018 Energy (In)Justice in Off-Grid Rural Electrification Policy: South Africa in Focus. *Energy Research and Social Science* 44: 152-171.
Morena, Edouard, Dunja Krause, and Dimitris Stevis, eds. 2020. *Just Transitions: Social Justice in the Shift Towards a Low-Carbon World*. London: Pluto Press.

Morris, Craig and Arne Jungjohann. 2016. *Energy Democracy: Germany's ENERGIEWENDE to Renewables*. Switzerland: Palgrave Macmillan and Springer Nature.
Nahm, Jonas. 2021. *Collaborative Advantage: Forging Green Industries in the New Global Economy*. Oxford: Oxford University Press.
Newell, Peter and Dustin Mulvaney. 2013. The Political Economy of the 'Just Transition'. *The Geographical Journal* 179(2):132-140.
Ogilvie, Matthew and Christopher Rootes. 2015. The Impact of Local Campaigns against Wind Energy Developments. *Environmental Politics* 24(6): 875-893.
Pegels, Anna, ed. 2014a. *Green Industrial Policy in Emerging Countries.* London: Routledge Studies in Ecological Economics.
Pegels, Anna. 2014b. Lessons for Successful Green Industrial Policy. In *Green Industrial Policy in Emerging Countries*, edited by A. Pegels. London: Routledge Studies in Ecological Economics.
Pettifor, Ann. 2019. *The Case for the Green New Deal*. London: Verso.
Princen, Thomas, Jack P. Manno, and Pamela L. Martin, eds. 2015. *Ending the Fossil Fuel Era*. Cambridge: The MIT Press.
Rennkamp, Britta. 2019. Power, Coalitions and Institutional Change in South African Climate Policy. *Climate Policy* 19(6): 756-770.
Roberts, J. Timmons, Romain Weikmans, Stacy-Ann Robinson, David Ciplet, Mizan Khan, and Danielle Falzon. 2021. Rebooting a Failed Promise of Climate Finance. *Nature Climate Change* 11: 180-182.
Rodrik, Dani. 2014. Green Industrial Policy. *Oxford Review of Economic Policy* 30(3): 469-491.
Sawyer, Suzana. 2004. *Crude Chronicles: Indigenous Politics, Multinational Oil, and Neoliberalism in Ecuador*. Durham: Duke University Press.
Scheidel, Arnim and Alevgul H. Sorman. 2012. Energy Transitions and the Global Land Rush: Ultimate Drivers and Persistent Consequences. *Global Environmental Change* 22: 588-595.
Schlömer, S., Bruckner, T., Fulton, L., Hertwich, E., McKinnon, A. Perczyk, D., Roy, J., Schaeffer, R., Sims, R., Smith, P., and Wiser, R. 2014. Annex III: Technology-Specific Cost and Performance Parameters. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. O. Edenhofer, et al. Cambridge and New York: Cambridge University Press.
Slough, Tara, Johannes Urpelainen, and Joonseok Yang. 2015. Light for All? Evaluating Brazil's Rural Electrification Progress, 2000-2010. *Energy Policy* 86(c): 315-327.
Smith, Pete, Daniel Martino, Zucong Cai, Daniel Gwary, Henry Janzen, Pushpam Kumar, Bruce McCarl, Stephen Ogle, Frank O'Mara, Charles Rice, Bob Scholes, Oleg Sirotenko, Mark Howden, Tim McAllister, Genxing Pan, Vladimir Romanenkov, Uwe Schneider, Sirintornthep Towprayoon. 2007. Review: Policy and Technological Constraints to Implementation of Greenhouse Gas Mitigation Options in Agriculture. *Agriculture, Ecosystems and Environment* 118: 6-28.
Smith, Roy and Karen E. McNamara. 2015. Future Migrations from Tuvalu and Kiribati: Exploring Government, Civil Society, and Donor Perceptions. *Climate and Development* 7(1): 47-59.
Sovacool, Benjamin K. and Ira Martina Drupady. 2012. *Energy Access, Poverty, and Development: The Governance of Small-Scale Renewable Energy in Developing Asia*. Burlington: Ashgate.
Sovacool, Benjamin K., Saleem H. Ali, Morgan Bazilian, Ben Radley, Benoit Nemery, Julia Okatz, and Dustin Mulvaney. 2020. Sustainable Minerals and Metals for a Low-Carbon Future. *Science* 367(6673): 30-33.
Steffen, Will, et al. 2015. Planetary Boundaries: Guiding Human Development on a Changing Planet. *Science* 347(6223): 736-747.
Stern, Nicolas. 2007. *The Economics of Climate Change: The Stern Report*. Cambridge: Cambridge University Press.
Stokes, Leah Cardamore. 2020. *Shortcircuiting Policy: Interest Groups and the Battle Over Clean Energy and Climate Policy in the American States*. Oxford: Oxford University Press.
Swilling, Mark. 2020. *The Age of Sustainability: Just Transitions in a Complex World*. London: Earthscan from Routledge.

Supran, Geoffrey and Naomi Oreskes. 2017. Assessing ExxonMobil's Climate Change Communications (1977-2014). *Environmental Research Letters* 12(8): 084019.
Tait, Louis, Holly Linnea Wlokas, and Ben Garside. 2013. *Making Communities Count: Maximising Local Benefit Potential in South Africa's Renewable Energy Independent Power Producer Procurement Programme*. London: International Institute for Environment and Development.
UNFCCC. 2021. Press Release: End of Coal in Sight at COP26. Online at https://unfccc.int/news/end-of-coal-in-sight-at-cop26.
Unruh, Gregory C. 2000. Understanding Carbon Lock-in. *Energy Policy* 28(12): 817-830.
Ürge-Vorsatz, Diana, Sergio Tirado Herrero, Navroz K. Dubash, and Franck Lecocq. 2014. Measuring the Co-Benefits of Climate Change Mitigation. *Annual Review of Environment and Resources* 39: 549-582.
Van de Graaf, Thijs. 2013. *The Politics and Institutions of Global Energy Governance*. Palgrave.
Veelen, Bregji van. 2021. Cash Cows? Assembling Low-Carbon Agriculture Through Green Finance. *Geoforum* 118: 130-139.
Victor, David G. and Thomas C. Heller, eds. 2007. *The Political Economy of Power Sector Reform: The Experiences of Five Major Developing Countries*. Cambridge: Cambridge University Press.

Victor, David G., David R. Hults, and Mark C. Thurber. 2011. *Oil and Governance: State-owned Enterprises and the World Energy Supply*. Cambridge: Cambridge University Press.
Voigt, Christina and Felipe Ferreira. 2015. The Warsaw Framework for REDD+: Implications for National Implementation and Access to Results-Based Finance. *Carbon & Climate Law Review* 9(2): 113-129.
Westley, Frances, Per Olsson, Carl Folke, Thomas Homer-Dixon, Harrie Vredenburg, Derk Loorbach, John Thompson, Mans Nilsson, Eric Lambin, Jan Sendzimir, Banny Banerjee, Victor Galaz, and Sander van der Leeuw. 2011. Tipping Toward Sustainability: Emerging Pathways of Transformation. *AMBIO* 40(762): 762-780.
Xia, Fang and Feng Song. 2017. Evaluating the Economic Impact of Wind Power Development on Local Economies in China. *Energy Policy* 110: 263-270.
Yok, Ryan M., Randy T. Simmons, and Brian C. Steed. 2013. *Green vs. Green: The Political, Legal and Administrative Pitfalls Facing Green Energy Production*. New York and London: Routledge.
Young, Oran R. 2017. *Governing Complex Systems: Social Capital for the Anthropocene*. Cambridge: The MIT Press.