Politics in the U.S. Energy Transition: Case Studies of Solar, Wind, Biofuels and Electric Vehicles Policy

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Abstract:

We examine the politics of US state and federal policy supporting wind and solar in the electricity sector and biofuels and electric vehicles in the transportation sector. For each technology, we provide two policy case studies: the federal Production Tax Credit (PTC) and state Renewable Portfolio Standards (RPS) for wind; state Net Energy Metering (NEM) and the federal investment tax credit (ITC) for solar; federal excise tax incentives and the Renewable Fuel Standard (RFS) for biofuels; and California's Zero Emission Vehicle (ZEV) mandate and federal tax incentives for electric vehicles. Each case study traces the enactment and later revision of the policy, typically over a period of twenty-five years. We use these eight longitudinal case studies to identify common patterns in the politics of US renewable energy policy. Although electricity and transportation involve different actors and technologies, we find similar patterns across these sectors: immature technology is underestimated or misunderstood; large energy bills provide windows of opportunity for enactment; once enacted, policies are extended incrementally; there is increasing politicization as mature technology threatens incumbents.

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1. Introduction

Over the past four decades, federal and state governments in the United States have passed numerous policies to promote clean energy. A large literature examines the technical, economic, and policy aspects of energy transitions (Smil, 2010). However, the political dynamics have received less attention (Meadowcroft, 2009; Hughes & Lipscy, 2013; Stokes, 2013). Since transformative energy policies threaten incumbent industries and impose substantial costs (Breetz, Mildenberger & Stokes, 2017), enacting and sustaining policies requires considerable political support. Yet despite widespread recognition that barriers to the energy transition are primarily political, rather than technological or economic (Delucchi & Jacobson 2011), we lack a cohesive literature on the politics that drive, constrain, and shape renewable energy policy—particularly in the United States.

Understanding the political dynamics of energy transitions requires detailed case studies of state and federal policy (Jacobsson & Lauber, 2006). In this paper, we examine eight longitudinal case studies of how politics shaped policy decision-making over the past three decades. We examine four low-carbon technologies: wind, solar, biofuels, and electric vehicles (EVs). For each technology, we trace how political agendas, actors, and institutions affected the enactment and evolution of two major state and federal policies. For wind energy, we examine the federal Production Tax Credit (PTC) and state Renewable Portfolio Standards (RPS); for solar, state Net Energy Metering (NEM) and the federal investment tax credit (ITC); for biofuels, federal excise tax incentives and the Renewable Fuel Standard (RFS); for EVs, California's Zero Emission Vehicle (ZEV) mandate and federal tax incentives.

This paper provides both empirical and theoretical contributions to research on energy transitions. Since the political histories of several of these policies are poorly documented in energy policy literature—including the Investment Tax Credit (ITC), the Renewable Fuel Standard (RFS), and various EV tax credits—our original case studies offer a significant empirical contribution. These cases also provide a counterbalance to the European emphasis in energy transitions research (Markard, Raven, & Truffer, 2012). Our analysis also contributes conceptual and theoretical development. Few articles conceptualize the changes across transportation and electricity as a single energy transition, but we find that they share similar politics, suggesting common challenges in the move away from fossil fuels. Examining these cases demonstrates that numerous policy factors have driven renewable energy policy adoption in the US: energy crises, financial recessions, national security, and environmental and public health concerns.

We identify four broad patterns in the politics of renewable energy policymaking. First, policymakers and incumbent industries often underestimated new energy technologies. Second, omnibus legislation tended to provide key political opportunities for renewable policies. Third, once enacted, supportive policies were often sustained through incremental extensions, despite moments of retrenchment due to expiring provisions. Fourth, as low-carbon energy technologies matured and began threatening incumbent fossil fuel industries, they became more politically contentious. We conclude that sustained political support for these technologies through long-term advocacy coalitions will be necessary to complete the renewable energy transition.

2. Energy Transition Politics

Many studies examine the technical, economic, and policy drivers of energy transitions. The political dynamics, however, have received less attention. Although the *importance* of politics is acknowledged, the literature lacks a cohesive theory of how political institutions and actors affect energy policymaking. Here we review recent developments from three relevant fields: political science, policy studies, and energy transitions.

In political science, a recent review described the subfield of energy politics as "relatively underdeveloped" (Hughes & Lipscy 2013). Most research dates to the 1970s-1980s and focuses on international political economy and oil geopolitics. Recent work in this subfield continues to emphasize national security and the political economy of incumbent fuels—not renewable energy. This emphasis is beginning to shift with new studies relating renewable energy to public opinion (Ansolabehere & Konisky 2014; Stokes 2013; Stokes & Warshaw 2017), electoral dynamics (Stokes 2015a), coalitional politics (Meckling and Jenner 2016), and green industrial constituencies (Aklin & Urpelainen, 2013). However, renewable energy remains an understudied topic in political science. Our paper highlights several important political dynamics that could be explored in future research, including layering of regulatory policies and tax incentives, and interactions between state and federal policy.

In the policy literature, scholars often analyze policymaking with theories such as the Multiple Streams model, Punctuated Equilibrium Theory, and the Advocacy Coalition Framework. Although these theories focus on slightly different actors, time scales, and causal mechanisms (Nowlin 2011), all emphasize windows of opportunity for policy change, especially following acute "focusing events" such as oil and nuclear crises (Carlisle et al. 2016; Grossman 2013; Nohrstedt & Weible 2010; Nohrstedt 2008; Smith

2002). Our paper builds on this literature by demonstrating how oil crises drove omnibus energy legislation, opening policy windows for wind, solar, biofuels, and EVs. In addition to considering policy enactment—the main focus of policy process theories—we also examine how policies were extended, revised, or retrenched. This requires understanding the interaction between policymaking and technologies over time (Breetz, Mildenberger & Stokes, 2017).

Energy transitions scholars tended to emphasize the technical aspects of innovation, niches, and socio-technical systems (Markard et al. 2012)—indeed the term "transition" is apolitical. However, calls for deeper engagement with politics, policy, and governance (Meadowcroft 2009; Meadowcroft 2011; Scrase & Smith 2009; Shove & Walker 2007) catalyzed research in this field. This emerging literature often emphasizes the structure of policy actors, including alliances (Lawhon & Murphy 2012), networks (Musiolik & Markard 2011), and advocacy coalitions (Jacobsson & Lauber 2006; Farla et al. 2012; Markard, Suter & Ingold 2016). Compared to energy studies in political science and public policy, the energy transitions literature has less emphasis on agenda-setting and crisis-driven policymaking, which may reflect its predominantly European epistemic community.

Several newer debates in this literature particularly resonate with our case studies. One area develops new theories about "regime resistance," including how incumbent fossil and automobile industries resist system transformation (Geels, Tyfield & Urry 2014) and how countervailing industries and grassroots social movements can push back (Hess 2014; Hess 2016). Our cases contribute to this literature, showing how incumbent industries may not resist initial policies, as well as how resistance increases over time as deployment scales up.

Another branch of energy transitions research emphasizes institutional aspects, including institutional values and priorities (Laird 2001; Kuzemko et al. 2016), institutional "layering" in which renewable energy programs are created without dismantling existing fossil fuel regimes (Laird 2016), and cross-national discursive-institutionalist comparisons of how actors mobilize ideas (Kern 2011). Our cases confirm that the US energy transition is being pursued through institutional layering rather than transformative reforms. We further contribute to this branch of research by showing that layering involves an interaction between regulatory polices and tax incentives, as well as between federal and state policies.

3. Research Methods

3.1. Process tracing in case studies

Each case study traces the emergence, enactment, and evolution of one policy. The case studies are longitudinal— they trace the policy over an extended period, typically about twenty-five years. For each case, our goal is to explain how political dynamics shaped policy outcomes; evaluating policy impacts, estimating costs, or explaining adoption rates are beyond the scope of this study, except insofar as these factors influenced policy decision-making.

In each case study in Section 4, we rely on process tracing, a research method developed primarily in political science. Process tracing reconstructs a chain of events to identify causal mechanisms within a case study (Beach and Pedersen, 2013; Trampusch and Palier, 2016). Process tracing first reconstructs the historical record, establishing *what* and *when* decisions occurred, with a particular focus on identifying the sequence of events. The procedure then moves towards explanation, examining *why* and *how* political decisions were made.

In the discussion in Section 5, we comparatively analyze across case studies with the goal of identifying common patterns in the politics of policy-making. This is an inductive form of comparative case study analysis that aims to generate hypotheses that can be generalized beyond the specific cases (Levy 2008). The relationships we uncover through this approach could be tested in future research through deductive case studies or quantitative analyses.

3.2. Case Selection

In this paper, we selected the two fastest-growing alternative energy sources in the electricity and transportation sectors (Figure 1). For each, we selected two key policies that drove investment and commercialization in recent decades. The timeline for key episodes of policy enactment are shown in Figure 2. Although many complementary policies have affected the energy transition, we focus on the most prominent policies for each technology.[1] Ultimately, our goal is to explain how these policies were created, rather than accounting for all factors affecting technology deployment.

This selection criteria resulted in a range of policy types, include both regulations and subsidies. For wind, solar, and EVs, it is notable that the regulations we examine are

[1] We focus on supply-side efforts to deploy new fuels and vehicles, not policies to increase efficiency. While efficiency is important, it does not necessarily drive substitution between energy sources and affects only the pace of decarbonization (Trancik, Chang, Karapataki, & Stokes, 2014).

typically state-level mandates (RPS, ZEV Mandate) while the subsidies are federal tax incentives (PTC, ITC, EV tax credits and rebates). For biofuels, both the blending mandate and tax incentives were enacted at the federal level. The case of solar NEM is primarily a regulatory policy, but is often seen of as involving some subsidization as well; in this way, it is a mixed case.

3.3. Data sources

To establish the policy timelines and identify underlying political drivers, we principally rely on primary data sources: speeches and testimony, legislative records, archival resources, and semi-structured interviews with policy staff and stakeholders.[2] Interviews focused on elite policy actors involved in the policy-making process, often providing a 'behind-the-scenes' account of the motivation for policy decisions. In addition to primary resources, we also use secondary sources such as newspaper articles and prior scholarly studies, particularly to provide some of the broader historical context.

4. Policy Case Studies

4.1 Wind energy

The US was an early leader in wind energy, with the then world's largest wind investments in California in the 1980s (Righter, 1996). Both state tax credits and federal policy supported these initial investments, especially the Public Utilities Regulatory Policy Act (PURPA) and the Business Energy Tax Credits in the 1978 National Energy Act. But after President Reagan allowed the Business Energy Tax Credits to expire in

[2] More complete citations of interviews and archival materials can be found in Breetz (2013) and Stokes (2015b).

1982 (Sherlock, 2011), the United States began to lag other countries, especially Germany and Denmark, in wind deployment (Lewis & Wiser, 2007). This section examines the two major policies driving wind deployment in the US since the late 1990s: the federal PTC and state RPS policies.

4.1.1. U.S. Production Tax Credit

The federal PTC provides a 1.5 ¢/kWh tax credit for the first 10 years of production from eligible renewable projects, notably wind.[3] It was established in the Energy Policy Act of 1992, which was a large omnibus energy bill developed during the first Gulf War. As initially established, the value was set in 1993 dollars, adjusted for inflation over time, and was meant to last until 1999 (Bird et al., 2005). Energy was put on the federal agenda after Iraq invaded Kuwait, causing oil prices to rise precipitously in mid-1990 (Carlisle et al. 2016; Grossman 2013).

In September 1990, President George H.W. Bush addressed Congress on the military crisis and energy policy. Bush had campaigned on an environmental platform to distinguish himself from Reagan and the backlash against his anti-environment policies (Layzer, 2012). The Bush administration was therefore expected to emphasize efficiency and renewables. But Bush did not even mention renewables in this speech. He instead emphasized that “we must then take advantage of our energy sources across the board: coal, natural gas, hydro, and nuclear.” The administration slowly formulated a response to rising energy prices, releasing a National Energy Strategy in February 1991 after prices

[3] The first PTC only applied to wind energy and closed-loop biomass. The Energy Policy Act of 1992 also created the Renewable Energy Production Incentive, which was very similar to the PTC but applied to non-profit entities, such as municipal utilities and rural electric cooperatives, rather than for-profit companies.

had begun to decline. There were disagreements between the Department of Energy, which proposed a 2 ¢/kWh PTC for renewables, and the White House, which removed this provision.[4] The White House's final strategy contained only modest renewables goals, such as a one-year extension of small federal tax credits.

When bills began to be debated in Congress in 1991, clear divisions emerged over nuclear regulations, Corporate Average Fuel Economy (CAFE) standards, and oil development in the Arctic National Wildlife Refuge (ANWR). These conflicts took up most of the legislative bandwidth, providing cover for less controversial and lower profile renewable energy provisions such as the PTC and tax incentives for alternative fuel vehicles (discussed in Section 4.4.2.). Interest groups, ranging from the Sierra Club to the American Petroleum Institute, spent most of their time on these controversial titles.[5] The Administration also kept the focus on these controversial provisions by threatening a veto for legislation *with* CAFE standards or *without* ANWR development.

Hence, one of the key provisions the law is known for today received little debate at the time. Both parties' proposals included versions of the PTC. The House Democrats, led by Representative Sharp, worked on a reform bill with planned renewable energy support.[6] But before they could offer a comprehensive proposal, the PTC was put into the Republican House bill. In short, the PTC was a small provision with bipartisan support and for which both parties sought to claim credit.

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[4] Keith Schneider, *New York Times* "Bush's Energy Plan Emphasizes Gains in Output Over Efficiency", Feb. 9 1991; "Legislative History of the Energy Policy Act of 1992" Volume 3.
[5] Clifford Kraus, "Energy Bill Is Derailed In Senate," *New York Times*, Nov. 2 1991.
[6] Sharp had also worked on this issue the year prior, through another renewable energy bill he sponsored: "Solar, Wind, Waste, and Geothermal Power Production Incentives Act 1990."

When the policy was enacted, renewable energy technologies were barely commercialized in the US. It was easy for both parties to support a policy that addressed energy insecurity by promoting ‘Made in America’ domestic energy sources. Further, these incentives were seen as overcoming market barriers blocking renewable energy deployment (Hirsh, 1999). Over the subsequent decades, the federal PTC went through repeated expirations and renewals, including in the Energy Policy Act of 2005 (discussed in Section 4.2.1). It was never extended again for as long as it was in the first law, leading to significant investor uncertainty and boom-bust cycles in wind energy development (Bird et al., 2005). Nevertheless, it proved critical to financing wind projects, particularly combined with state RPS requirements.

4.1.2. Renewable Portfolio Standards

RPS policies require a percentage of a state’s electricity to come from renewable energy, typically through private utility targets. Debates center around which technologies should be eligible, how high the target should be, and whether targets should be binding or voluntary. Eligible technologies typically include wind, geothermal, solar and biomass (Carley, 2011). In practice, while these policies targeted various technologies, most RPS policies were met primarily (68%) with wind energy (Barbose, 2016).[7]

To date, 37 states have passed RPS policies.[8] They were first enacted in the 1990s in several states[9] and developed in two major waves (Hogan, 2008). The first occurred

[7] Further, the state may require that a certain portion of the standard come from a specific renewable energy technology, through a ‘carve-out.’ This is most commonly done for solar energy, which has higher costs than other renewable technologies and therefore would not be installed without a specific incentive.
[8] Some of these policies are voluntary goals rather than binding policies and some have since been repealed.
[9] Some claim that Minnesota was the first state to act, although this RPS policy was less comprehensive.

between 1994 and 2002, with RPS policies packaged as part of electricity restructuring laws. The second occurred after electricity restructuring fell out of favor, when many states enacted standalone RPS policies.[10] In addition, from 2005 onwards, several states enacted non-binding voluntary RPS policies. Since Kansas passed its RPS in 2009, no new mandatory RPS policies have been enacted.

The Texas case illustrates the dynamics that unfolded across other states over time. Like many early RPS policies, Texas's was first passed as part of an electricity restructuring law intended to create competitive power markets (Stokes, 2015b). When then Governor George W. Bush took office in 1995, he made it clear that electricity restructuring was imminent. With his leadership, electric restructuring was seriously considered in the 1997 legislative session through several bills. Key interest groups pushing for restructuring included numerous oil and gas companies, organized through the Texas Coalition for Competitive Electricity, as well as Enron which had bought one of the largest US wind companies and sought to expand the market for renewables. However, opposition from the Association of Electric Companies of Texas (AECT) and rural electric cooperatives blocked the bill. Clearly, the investor-owned utilities (IOUs), allied through the AECT, preferred to remain under status quo regulation than end up with stranded costs. Consequently, electricity deregulation failed in 1997.

Efforts continued in the next legislative session through the Texas Electric Restructuring Act of 1999 (SB 7), an omnibus bill addressing multiple issues. While private utilities and pro-restructuring companies remained preoccupied with stranded costs and market rules, environmental and renewable energy advocates saw an

[10] Ohio, however, still enacted its RPS as part of a later restructuring reform in 2008.

opportunity to ally with deregulation advocates. They worked on three significant provisions in the final version of SB 7: requiring old coal plants, exempt from the 1971 Texas Clean Air Act (CAA), to cut air pollution emissions; establishing energy efficiency goals; and the RPS. Including an RPS as part of the Texas restructuring bill was not unusual. Deregulation provided a common opportunity for introducing RPS policies—in fact, prior to 2000, all but one state-level RPS was enacted as part of a significant electricity restructuring reform bill (Hogan, 2008).

Once implemented, Texas built massive amounts of wind and expanded its RPS in 2005, including a major transmission investment. Despite this early success, in subsequent years, renewable energy advocates in Texas tried, but failed, to expand its RPS to include solar. Large energy consumers and oil and gas companies opposed Texas's renewable energy policies and, given their political influence, were able to block reforms. Instead, repeal politics began to play out in Texas. As was the case in Kansas, these repeals were largely symbolic, since the RPS targets were already met. But in other RPS cases, such as West Virginia and Ohio, successful RPS retrenchment has stymied new growth in wind energy.

4.2 Solar photovoltaics (PV)

The United States was slower than other countries, such as Germany and Japan, to deploy solar PV technology. Still, the US remains one of the largest and most important markets for solar PV. Like wind energy, solar was boosted by state RPS policies. In addition, solar energy deployment has been strongly driven by the federal Investment Tax Credit (ITC) and state level net energy metering (NEM) laws.

4.2.1. Net-metering

Net-metering policies, passed in 43 states, set the rules for compensating distributed power supplied to the grid. Most commonly, net-metering allows customers to connect their solar PV systems to the grid and receive compensation for their excess power at the retail electricity rate. California's 1995 NEM law illustrates the political dynamics that played out across later states. This law marked the first in a wave of modern NEM adoptions: before California passed their law, only a handful of states had acted; afterwards, 16 states rapidly adopted net metering laws between 1997-1999 (Carley, 2011; Stokes, 2015b; Stoutenborough & Beverlin, 2008).

In the early 1990s, several solar advocates began developing net metering as a policy to advance solar PV deployment in California. The idea that solar PV could provide grid-tied distributed generation was innovative, since most projects at that time were solar water heating or off-grid PV. By then, seven states had enacted NEM laws, but many were not applicable to renewables.[11] One policy entrepreneur, Tom Starrs, wrote a short paper in 1994 that outlined how net metering would work for customer-owned, utility-integrated solar PV (Starrs, 1994). He partnered with other renewable energy advocates, including the California Solar Energy Industry Association (CALSEIA), to introduce a NEM bill. Although CALSEIA's members were almost exclusively solar hot water companies, the organization saw potential for broadening their work into solar electricity.

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[11] Iowa also had an implicit NEM law beginning in 1984, because of the way the Iowa Utilities' Board interpreted PURPA. Maine also had a law, but it only applied to CHP projects.

In 1995, the advocates convinced state Senator Al Alquist, to sponsor legislation (SB 656) that allowed for systems up to 10 kW, capped at 0.1% of the utilities' peak demand. These size and scale limitations were tactical. The advocates knew utilities would oppose the bill and recognized how much more influential the incumbents were in the legislature. Thus, these were concessions to their opponents that would not have a material impact on the outcome. Installing 0.1% solar PV (50 MW) would be a huge success, since in 1995 only 600 MW of solar PV existed globally (Sawin, 2013). The 10 kW limitation was also designed to target residential installations. The advocates knew that large, commercial customers would not need net metering, because their load was relatively constant. By contrast, a residential customer's demand could vary greatly over a day. With this policy, citizens could feed electricity into the grid during the daytime when their home's electricity demand was low.

These limits also allowed the advocates to calculate each IOU's maximum revenue losses, thereby demonstrating that the costs would be inconsequential. Nevertheless, two of three IOUs actively opposed the bill, arguing that NEM was a ratepayer subsidy because customers would be paid a retail rate for a wholesale commodity. As one utility wrote to Senator Alquist in 1995, net metering was a "bold scam by the solar power industry to force our electric customers to subsidize the sale of expensive residential photovoltaic systems".[12] From the outset, the utilities raised concerns over cost-shifting to other customers.

But given the small scale of the solar PV industry at the time and the strict limits in the bill, these arguments did not resonate. The bill passed the California Senate 25-7

[12] PG&E wrote this in a letter. U. Irfan, "Solar, utility companies clash over changes to net metering," *ClimateWire,* September 3, 2013.

and the Assembly 57-4. All the Democrats in both houses and 75% of Republicans supported the bill. It was remarkable that these poorly funded renewable energy advocates, in a coalition with environmental groups and consumer advocates, were able to pass a net metering bill in California. In part, it benefitted from simple logic: equal compensation for power bought and sold struck legislators as fair. Further, it was easy to implement and would not cost the state money. Finally, the utilities were very busy with political battles over deregulation by 1995, making NEM a minor issue by comparison. In short, their attention was divided, and while IOUs voiced opposition, they did not prioritize blocking this bill, given it was far less consequential than electricity restructuring.

After the California policy success, grassroots state and national renewable energy advocates focused on diffusing NEM across the states (Faden, 2000). EPA regional offices also played a role in diffusing state NEM policies (Stoutenborough & Beverlin, 2008). Since solar PV remained very expensive in 1995, the laws had little immediate effect on solar adoption, which helped make the utilities' dire predictions seem unreasonable. In fact, most utilities at this point expected that renewables would not be widely adopted due to their high costs, so they were not threatened by NEM laws. When these policies were enacted across the majority of US states, they were not controversial and were not expected to result in significant solar installations. It was only in time, particularly after the federal ITC was passed and the solar leasing model developed, that these policies began to pose larger threats to incumbent utilities. Now that solar deployment has grown and begun to threaten utilities through the 'death spiral', efforts to repeal net metering laws have also increased (Stokes, 2015b).

4.2.2. The Federal Investment Tax Credit

Net-metering held new promise with the federal Energy Policy Act of 2005 (H.R. 6). This comprehensive bill took several years of negotiation and comprised numerous policies, including the RFS (discussed in Section 4.3.2). For solar PV, it created a 30% ITC for commercial and residential systems, with residential credits capped at $2,000.[13] The policy was later extended and expanded numerous times, including two important revisions under a Republican president.

By the early 2000s, there had not been a major federal energy law in a decade. Aside from the short-lived price shock in 1990, oil prices had stayed low and steady from 1985 to 2000, hovering around $20 a barrel and rarely surpassing $25.[14] But rising global demand, especially in Asia, caused prices to begin rising in the early 2000s, doubling to $40 a barrel by 2004. As with previous oil price increases (Arnold, 1992; Breetz, 2013; Carlise et al. 2017), this put energy on the federal agenda. The domestic natural gas industry was also struggling to meet rising demand, leading to price spikes beginning in January 2001 and continuing throughout President George W. Bush's two terms.[15] In addition, there was mounting global pressure on the US to address climate change given the recently finalized Kyoto Protocol. Both the President and Congress were interested in passing an energy bill to show leadership on these intersecting challenges.

Deliberations over energy reforms began four years prior to the law's passage, with a similar top-down approach as President George H.W. Bush used in the 1990s.

[13] The residential credit is listed under "Sec. 1335. Credit for residential energy efficient property" and the business credit is listed under "Sec. 1337. Business solar investment tax credit."
[14] US EIA, Petroleum & Other Liquids, Spot Prices for Crude Oil and Petroleum Products
[15] US EIA, Henry Hub Natural Gas Spot Price (Weekly), Natural Gas Futures Prices (NYMEX).

Two weeks into the President George W. Bush administration, Vice President Dick Cheney was appointed Chairman of an Energy Task Force comprised of several cabinet members. The group met ten times with conventional energy industry lobbyists, including utilities, fossil fuel and nuclear groups. Records suggest that renewable energy groups were not consulted.[16] Their final report in May 2001 contained only one provision for renewable electricity: "Earmark $1.2 billion of bid bonuses from the environmentally responsible leasing of ANWR to fund research into alternative and renewable energy resources."[17] By contrast, clean coal was earmarked for $2 billion, with no ANWR drilling contingency.

The two chambers struggled to agree on an energy bill due to inter- and intra-party conflicts. Although Republicans controlled both Houses with narrow majorities for most of the early 2000s, the Democrats held the majority in the Senate from mid-2001 until January 2003. The Senate requirement for 60 votes to invoke cloture created a need for compromise (Oppenheimer, 2011). Thus, the Senate was more pro-renewables than the House throughout the energy bill debates. Most Senate energy reform bills included a 10% RPS proposal, which the House continuously and successfully resisted. Opposition to the federal RPS likely stemmed from utilities and oil and gas industries lobbying specific House members (Karapin, 2016). The Senate bills also contained more renewable energy tax incentives. By contrast, the House bills hewed more closely to fiscally-conservative Republicans' preferences. Since the 1970s fossil fuel constituencies were well sorted into the party, particularly in oil-rich Southern states (Oppenheimer,

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[16] United States General Accounting Office, Report to Congressional Requesters, Process Used to Develop the National Energy Policy, August 2003.
[17] National Energy Policy, Report of the National Energy Policy Development Group, May 2001.

2011). Consequently, the Republican House majority passed three energy bills between 2001-2005 that emphasized oil and gas, with renewables provisions all but absent.

Given continuing conflict between the two houses, no energy bill passed in Bush's first term. But high oil prices kept energy policy on the agenda. In early 2005, the solar industry began a concerted effort to lobby Congress for a new tax incentive, and increases for solar R&D and federal procurement. These were ambitious targets for a small industry: at the time, the Solar Energy Industries Association (SEIA) estimated that 20,000 people were employed in solar jobs, with only 350 MW of solar PV installed in the US.[18] Previous versions of the energy bill had died because of perceptions that the costs were too high, suggesting that requesting *more* tax reductions would be difficult. But the industry targeted Republican Senators and Representatives whose districts benefitted from solar employment, finding more success with the Senate.

By April 2005, the President began to grow impatient at the disagreements between the two chambers. "America should not live at the mercy of global trends and the decisions of other nations," Bush said. "For more than a decade, this country has not had a comprehensive national energy policy, and now is the time to change it."[19] The House continued to pass Republican versions of the bill, with an emphasis on oil and gas, while the Senate pursued a bipartisan approach, excluding particularly controversial provisions including ANWR development, and Methyl Tertiary Butyl Ether (MTBE) liability protection. Controversies over high-profile conflicts provided cover for renewables. After conference, the final bill looked far closer to the Senate version than

[18] Ben Geman, *Greenwire*, "Industry seeks tax incentives, research funding", Jan 26, 2005.
[19] Quoted in Mary O'Driscoll, *E&E Daily*, "House backs ANWR drilling, keeps moving on energy bill", April 21, 2005.

the House, and contained a “Business Solar Investment Tax Credit.” Still, the law was hardly a strong signal that the energy transition was imminent, with 1.5 times more money for nuclear and fossil technologies than renewables and energy efficiency.[20]

The solar ITC was only meant to last for two years, expiring at the end of 2007. However, in 2006, the policy was extended one additional year. During the financial crisis in 2008, mere months before the ITC would have expired, the policy was extended for another eight years. In this way, the financial crisis created another policy window, allowing advocates to frame their preferred policies as job creation and economic stimulus measures. The policy would have expired again at the end of 2016—but by then the ITC and NEM policies had combined to create new actors: solar leasing companies. Just before the credit would have expired once again, the now much larger solar industry successfully lobbied for a long-term extension through The Consolidated Appropriations Act of 2015. Currently, the ITC is scheduled to expire in 2021.

4.3 Biofuels

Since the 1970s, diverse policies have supported biofuels (Solomon, Barnes & Halvorsen 2007; Carolan 2010). We focus on two key federal policies: excise tax incentives (1978-2011) and blending mandates (2005-current). Both were established by omnibus energy legislation during acute, intersecting crises—including high oil prices, struggling farm economies, and environmental concerns—which created diverse pro-ethanol coalitions..

4.3.1 Excise tax exemptions and credits

[20] Tax reduction summary: $5.8 billion for efficiency, renewables and renewable fuels; $8.7 billion for nuclear and fossil technologies including ‘clean coal’.

For over thirty years, ethanol was supported through reductions in the federal excise (sales) tax. During the farm crisis of the mid-1970s, when farmers suffered from crop surpluses, depressed grain prices, and record debt, ethanol emerged in a grassroots "prairie populist movement" (Bernton, Kovarik, and Sklar 2010). Large agribusiness firms, namely Archer Daniels Midland (ADM), came to dominate ethanol production by the late 1970s, but when Nebraska farmers formed the National Gasohol Commission and started lobbying Congress in 1976, the industry was perceived as small-scale and "little threat to other interests," thus generating little opposition (Sperling 1988, 65).

Senators from Midwestern farm states began sponsoring ethanol legislation. The Food and Agriculture Act of 1977 authorized a modest loan guarantee program. The National Energy Act of 1978 introduced larger subsidies, including a 4 ¢/gallon excise tax exemption for "gasohol" (i.e., gasoline containing at least 10% alcohol by volume). The gasohol tax exemption, which was worth 40 ¢/gallon of ethanol at a 10% blend, catalyzed the industry.

The tax exemption was not controversial and received widespread bipartisan support (Dirks 2010). One reason was that alcohol fuels could be produced from many sources, including methanol from coal (Soloman 1977; Seaberry 1979). Moreover, the enormity of the National Energy Act provided political cover. This was another case of a low-profile renewable energy tax policies passing with relatively little scrutiny in omnibus energy legislation.

Building on this success, an Alcohol Fuels Caucus was created in 1979. Two new crises gave them more legislative opportunities: an oil shock following the Iranian revolution in late 1979, and a US grain surplus caused by an embargo on grain sales to the Soviet Union in early 1980. These events spurred a “blizzard” of White House and Congressional activities on ethanol (Bernton, Kovarik, and Sklar 2010). In the 96th Congress, 82 bills related to ethanol were introduced —10% of which passed, in contrast to only 2% of most bills. Most importantly, the Crude Oil Windfall Profit Tax Act of 1980 extended the gasohol tax exemption from 1984 to 1992, and the Gasohol Competition Act of 1980 established a 54 ¢ /gallon ethanol import tariff to ensure that US tax exemptions did not subsidize foreign producers. The White House also created an Office of Alcohol Fuels in the Department of Energy with ambitious goals for ethanol and methanol.

After the crisis-driven policy-making of the 1970s, the 1980s and 1990s were a period of relative stability and incrementalism. Congress enacted several new policies to support ethanol, including additional subsidies as well as automobile and fuel regulations. The industry’s priority, however, was shoring up the gasohol tax exemption. In the early 1980s, when the industry was small and struggling with low oil prices, Congress twice raised the rate: in 1982 to 5.4 ¢/gallon and in 1984 to 6.0 ¢/gallon. But by the end of the 1980s it cost American taxpayers $500 million per year in reduced revenue for highway maintenance,[21] which spurred considerable opposition. The ethanol industry’s consolidation under ADM, which by then produced three-quarters of US corn ethanol, also eroded its grassroots appeal.

As ethanol’s broad-based coalition eroded, its Congressional patrons resorted to hard-ball tactics. At the end of the legislative session in 1989, Senator Robert Dole (R-KS) blocked floor debate on a steel import bill until the Senate extended the gasohol tax

[21] The federal excise tax on motor gasoline is earmarked for the Highway Trust Fund.

exemption to 2000. As a methanol lobbyist explained, "Without hearings … and on just about the last day of a session, Dole was trying to push through a seven-year multi-billion dollar tax expenditure. It was shameless" (Weiss 1990). Dole succeeded in getting the Senate to hold hearings the following year, when the exemption was successful extended. The extensions did not stop there. The Energy Policy Act of 1992 extended the exemption to other alcohol fuel blends, and another 1998 bill extended it through 2007.

Although extending the tax exemption was the industry's priority, behind the scenes was a growing schism. The agenda of the primary trade organization, the Renewable Fuels Association (RFA), was strongly driven by ADM. Since ethanol was a sideline to ADM's high fructose corn syrup business, their overriding goal was maintaining per-gallon subsidies. Growing the industry threatened their interests, because it could erode their market value and make subsidy costs more visible (and therefore politically vulnerable). Other industry factions, however, wanted policies to expand ethanol's market (Weiss 1990; Breetz 2013). Their opportunity came after 1998 when methyl tertiary butyl ether (MTBE), a fuel oxygenate in gasoline, was found leaking into groundwater. States began banning MTBE, and refiners turned to ethanol as a substitute.

Once again, as ethanol production increased, so did the taxpayer cost of the subsidies. In response to the backlash, Senator Grassley (R-IA) introduced a bill in 2004 to convert the tax *exemption* into a tax *credit*, the Volumetric Ethanol Excise Tax Credit (VEETC). VEETC gave fuel blenders a tax credit of 51 ¢/gallon of ethanol. This shifted the burden of forgone revenue from the Highway Trust Fund to the U.S. Treasury's General Fund, which was intended to ease the opposition. While VEETC received little attention during enactment, opposition grew as its costs continued to balloon (Munro

2015). Consequently, VEETC was reduced to 45 ¢/gallon in 2008 and extended for one year in 2010. Although proponents fought hard to maintain VEETC, it became politically untenable because of escalating costs and its seeming redundancy once an aggressive blending mandate, the revised RFS, passed in 2007. VEETC was allowed to expire in January 2012, bringing an end to three decades of ethanol tax incentives.

4.3.2 The Renewable Fuel Standard (RFS)

The RFS requires fuel providers to blend a minimum quantity of biofuels into the US petroleum supply each year, culminating in 36 billion gallons in 2022. The policy was developed in two phases: a modest RFS (RFS1) in the Energy Policy Act of 2005 and a massively expanded RFS (RFS2) in the Energy Independence and Security Act of 2007. In both cases, advocates for rural jobs, national security, and environmental protection supported biofuels. But different issues and partisan contexts shaped each policy's scope and scale.

The RFS1 was primarily designed to address fuel quality in the wake of state MTBE bans (Breetz 2013). Ethanol and MTBE are blended into gasoline to boost fuel oxygen content and octane levels, which promotes more complete combustion and thereby reduces smog. Refiners began using these oxygenates after lead was phased out of gasoline in the 1970s. The CAA Amendments of 1990 further boosted oxygenates with two provisions: the Reformulated Gasoline Program mandated a year-round 2% fuel oxygen content in the nation's nine worst ozone attainment areas, and the Oxygenated Fuel Program mandated a winter 2.7% oxygen content in 39 carbon monoxide non-attainment areas (Munro 2015).

The oil industry preferred MTBE to ethanol due its lower cost and easier handling, but panic set in after a 1998 California study found 10,000 drinking water sites contaminated by MTBE (Munro 2015). Numerous states, starting with California in 1999, began banning or phasing-out MTBE. The EPA assembled a commission to study the issue, leading to recommendations in 2000 to reduce or ban MTBE and replace the oxygenate standards with a biofuel blending mandate.

The farm lobby strongly welcomed this proposal. Environmental groups were reasonably supportive because they opposed MTBE. Oil and refining groups were willing to consider an ethanol mandate in exchange for dropping the oxygenate standards (Breetz 2013). Nevertheless, it took five years to hammer out compromise legislation. The first version in 2002 failed, partly because California and New York Senators opposed provisions protecting MTBE producers from liability lawsuits, but more importantly because it was part of a larger energy bill brought down by controversy over ANWR (as discussed above in Sections 3.1.1. and 3.2.2). It failed again in 2003 due to House conflicts over MTBE liability. Finally, in 2005, sharply rising gasoline prices put tremendous pressure on Republican leadership to pass major energy legislation. Bill sponsors agreed to drop the liability provisions, and the RFS1 was successfully enacted in the Energy Policy Act of 2005. It is important to note that initial goals were so modest— 4 billion gallons in 2006, rising to 7.5 million gallons by 2012— that they were immediately exceeded. Rather than forcing a market uptake of ethanol, the RFS1 simply institutionalized changes already underway in fuel markets.

The regulation was revised only two years later. Rising oil prices and protracted war in the Middle East deepened the public's concern with oil dependence. President

George W. Bush made "addiction to oil" a centerpiece of his energy platform, proposing a 35 billion gallon Alternative Fuel Standard in January 2007. Congressional Democrats, who sought to demonstrate their own leadership on energy issues after winning control of the House and Senate in 2006, 'bid up' the President's proposal to create the 36 billion gallon RFS2 (Breetz 2013). While Republicans saw the issue as addressing national security, Democrats were more focused on clean fuels (Munro, 2015). Still, the policy was not a simple culmination of complementary interests. Behind-the-scenes negotiations were incredibly contentious, in part because the rapid growth of ethanol raised concerns about its impacts on food prices, pollution, and land use (Delshad 2009, Breetz 2013, Mondou, Skogstad, and Houle 2014).

Ultimately, the RFS2 increased the blending targets to 36 billion gallons by 2022, nearly 20% of projected motor fuel consumption. Numerous environmental provisions were also added, including sub-mandates for advanced and cellulosic biofuels and standards for lifecycle greenhouse gas reductions. Thus, the regulation was both expanded and "greened," reflecting the multidimensional interests in the pro-ethanol policy coalition (Mondou, Skogstad, and Houle 2014).

Since enactment, the sub-mandates for cellulosic ethanol were repeated scaled back due to slow commercialization. The EPA's rulemaking on these fuels has been repeated litigated in court, with lawsuits filed by both biofuel opponents and advocates. Political backlash has also been fuelled by rising compliance costs, since US ethanol production has reached the "blend wall" of 10% ethanol, after which further blending requires a large expansion of the E15 or E85 market. The RFS2 has survived thus far through incremental adjustments, but its political viability going forward is precarious.

4.4 Electric Vehicles

Currently there are 438 incentives for EVs in the US, including tax rebates, sales tax or registration fee exemptions, reduction of parking fees, subsidies for charging infrastructure, and access to high occupancy vehicle (HOV) lanes.[22] We focus on two instruments: California's Zero Emission Vehicle (ZEV) mandate (1990-current) and federal tax incentives (1992-2006, 2008-current). Federal air quality regulation, specifically the Clean Air Act's (CAA) ozone standards, provided the underlying driver. In the late 1980s, California developed the ZEV mandate to meet its CAA obligations. Tax breaks and other incentives were layered as complementary policies to overcome the economic barriers to EV adoption. EV policymaking thus shows layering between regulatory and tax policies, as well as interaction between federal and state policy.

4.4.1. California's Zero Emission Vehicle mandate

California defines ZEVs as vehicles with "no exhaust or evaporative emissions of any regulated pollutant." In September 1990, California mandated that automakers sell a certain percentage of their new cars as ZEVs: 2% by 1998, 5% by 2001, and 10% by 2003 onwards. Although ostensibly technology neutral, it was a de facto EV mandate (Bedsworth and Taylor 2007). The mandate is seen as a radical, technology-forcing regulation. However, it had to be revised over the years to reflect the slow development of EVs and accommodate "partial zero emission vehicles" such as hybrids. After decades

[22] U.S. Department of Energy, Alternative Fuels Data Center. 'All laws and incentives sorted by type.' http://www.afdc.energy.gov/laws/matrix?sort_by=tech

of innovation, infrastructure development, and incentives, EVs still only account for 3% of California's new vehicle sales.

The catalyst for the policy was California's non-attainment of federal air quality standards, particularly CAA standards for ground level ozone, in 1987-1988 (Collantes and Sperling 2008). California had long struggled to control ozone and smog through motor vehicle regulations. The state's 1964 vehicle emissions standards even pre-date the CAA, which is why California has special authority to set its own vehicle emissions standards. But by the late 1980s, California's continued CAA non-attainment meant that it risked losing federal transportation funding. This put vehicle emissions high on the policy agenda with dampened opposition (Collantes and Sperling 2008).

In 1988, California passed a state-level Clean Air Act that directed the California Air Resources Board (CARB), the agency responsible for air quality regulation, to take necessary, cost-effective and technically feasible actions to reduce vehicle emissions. Over the next two years, CARB developed a Low Emission Vehicle and Clean Fuels Program (LEV) that included the ZEV mandate (Grant 1995, Hoogma 2000).

Interestingly, pre-1990 drafts of LEV did not include ZEV provisions. Although Don Drachand, CARB's Motor Vehicle Emissions Control Division Chief, was convinced that ZEVs were needed to meet air quality standards with future population growth, he saw their commercial potential as limited by high costs and low battery range. This turned around when General Motors unveiled an EV concept car in Los Angeles in January 1990, which "mistakenly led the regulator to believe that electric vehicles … could be mandated" (Kemp 2005, 169). With little economic or technical analysis, Drachand and his staff proposed the ZEV provision late in the LEV formulation. CARB's board adopted the program in September 1990. As one CARB official explained, "it just kind of slipped through … People weren't looking at it" (Kemp 2005, 178). Stakeholders saw it as an afterthought and focused their lobbying attention on more prominent clean fuel provisions. Thus, although the ZEV mandate is now seen as a major policy achievement, at the time it was seen as a minor provision (Collantes and Sperling 2008).

The mandate was subsequently altered to reflect technology developments. In 1996, after concluding that long-range batteries would not be available until 2001, three years later than expected, CARB delayed the mandates for 1998-2001. Instead, they signed a memorandum of understanding (MOU) wherein automakers voluntarily agreed to develop manufacturing capacity and promote ZEVs. Although CARB's chairman emphasized that "[t]his is not a political decision, it is a technical decision," the deferral also rested on non-technical assumptions that the premature introduction of short-range EVs' would poison the market (Brown 2001).

Program reviews in 1998 and 2000 led to further reforms, allowing automakers to meet 40% of their obligations with partial ZEV (PZEV) and advanced technology ZEV (AT-ZEV) vehicles, such as hybrids. Automakers challenged the cap in court, and in 2003 CARB created an "alternative compliance path" allowing manufacturers to meet their entire mandate with PZEVs and AT-ZEVs. Most recently, in 2012 CARB extended the ZEV mandate to 15% by 2025. Nine other states (Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont) have also adopted the ZEV mandate.

Although CARB was overly optimistic in forecasting ZEV commercialization, the mandate successfully forced automakers to develop and sell EVs. Still, until recently battery prices have kept EV costs high. States with ZEV mandates have also needed complementary incentives to stimulate adoption. Notably, California's U.S. Senators and Representatives took the lead in pushing for federal tax incentives. The regulatory context of the federal CAA and state ZEV mandates thus helped drive subsequent tax incentives (Milne 2012).

4.4.2 Federal and state tax incentives

In the late 1980s, while California was developing its ZEV mandate, federal politicians were also paying attention to air quality and vehicles. President George H.W. Bush similarly proposed a mandate requiring automakers to sell 1 million "clean fuel" vehicles annually in the nation's nine most polluted cities. This mandate was included in drafts of the CAA Amendments of 1990 but was eliminated in an automaker-backed amendment from Representative John Dingell (D-MI) (Richardson 1989). When Congress took up vehicles again in the Energy Policy Act of 1992, the emphasis shifted from regulatory "sticks" to voluntary "carrots," including tax incentives.

As discussed above, although the Energy Policy Act of 1992 was intended to reduce oil imports through fuel economy and increased drilling, it also opened a policy window for emerging and renewable energy technologies. In addition to establishing the PTC and extending biofuel tax credits, the bill included several alternative fuel vehicle policies: $40 million for EV research, $50 million for EV demonstrations, a $4000 income tax credit for purchasing an EV, and a $2000 income tax deduction for purchasing Clean-Fuel Vehicles (including natural gas, hydrogen, or 85% alcohol fuels).

Both tax breaks had sunset provisions that reduced them by 25% in 2002, 50% in 2003, and 75% in 2004, after which they would be eliminated.

The Clean-Fuel Vehicle tax deduction was sponsored by a bipartisan coalition of natural gas, ethanol, and automobile interests. Environmental advocates also supported the policy, but House and Senate debates strongly emphasized industrial interests. For example, Senator Peter Domenici (D-NM) explained, “My state is a tremendous natural gas producer and I am looking forward to the day I can buy my first natural gas powered car,” while Rep. Andrews (D-TX) also discussed natural gas and further explained that “alternative fuel technology represents a real chance for American car makers to leapfrog the Japanese.” In contrast, Representatives from California primarily sponsored the EV provisions, presumably to help achieve the ZEV mandate (Milne 2002). They were joined by co-sponsors from coal-producing states, creating a “bootleggers-and-Baptists” coalition of normative and material interests (Yandle 1983). Most EV provisions in the Energy Policy Act of 1992 were based on earlier proposals from California Representatives from 1990 and 1991. However, the tax credit only appeared in the final conference bill with virtually no discussion or explanation.

Later legislation extended and reformed these tax incentives. In 2002, the Job Creation and Worker Assistance Act pushed back their phasedown by two years. In 2005, the Energy Policy Act replaced the Clean-Fuel Vehicle tax deduction with an Alternative Motor Vehicle tax credit emphasizing hybrid vehicles. The new tax credit was capped at 60,000 cars per automaker, which helped U.S. automakers since Toyota and Honda entered the hybrid market earlier and would lose their tax credits first (Harris 2009).

The 2005 legislation allowed the EV tax credits to expire. Yet in another instance of tax incentives being grafted onto omnibus legislation, EV tax credits were revived as $7500 Plug-In Electric Drive tax credit in the Emergency Economic Stabilization Act of 2008, passed during the financial crisis. This new credit was originally capped at 250,000 vehicles nationwide; the American Recovery and Reinvestment Act of 2009 expanded it to 200,000 vehicles per automaker through 2014, and the American Taxpayer Relief Act of 2014 further extended the expiration date. Notably, none of these recent acts focused on energy, but they provided political opportunities to enact or extend EV tax incentives. In addition to federal EV tax credits, many states offered their own EV tax incentives. However, as EV sales rose and the cost of the tax incentives ballooned, opponents pushed for retrenchment. Several states that used to provide EV tax breaks have repealed them or allowed them to expire, such as Georgia and Illinois, while another ten states enacted additional EV taxes of $50-200 per year.

5. Discussion

The electricity and transportation sectors are rarely examined together. They are different socio-technical regimes with different technologies, resources, and actors. In electricity, the incumbent industries are utilities, coal, and natural gas, while new entrants are solar and wind; in transportation, incumbents include oil and automobile companies, while new entrants include corn, ethanol, natural gas, and EV firms. Moreover, policymaking in these sectors tends to respond to different environmental and economic problems. Air quality, climate change, jobs, and electricity deregulation drove renewable electricity policy; foreign oil dependence, urban smog, rural development, and fuel additives' toxicity drove alternative fuels and vehicles policy.

Nevertheless, in comparing these case studies we find important similarities in policymaking. Partisan dynamics were similar: Democrats typically initiated these policy proposals, though Republicans also supported or even led some proposals. Policy instruments and policymaking venues were also similar: federal policy since the late 1970s relied more on "carrots" of tax incentives and RD&D funding (Sherlock, 2011), with state policy since the 1990s providing more regulatory "sticks," often beginning in California. Moreover, initial policy enactment in both sectors relied on diverse coalitions, which eroded over time as crises faded away, new industries emerged, and policies' costs rose in scale and visibility. In addition to these general similarities, the comparative case studies enable us to identify common patterns in policy decision-making. Here we describe four patterns in the politics of policy enactment and evolution and discuss how these contribute to the existing literature on the politics of energy transitions.

5.1. Immature technology is underestimated or misunderstood

In the early stages of policy adoption, there is high uncertainty (Stokes, 2015b), and immature renewable energy technologies' potential are often poorly understood. Renewable technologies tend to be underestimated, perhaps because they involve new entrants and initially high costs. This may also reflect public wariness after costly failures in nuclear or fossil technologies, including nuclear fusion, synthetic fuels, and 'clean coal.' On the other hand, emerging technologies may be overestimated due to over-promising by investors and technology developers. Either way, rather than being a barrier to policymaking, the uncertainty around new technologies often helped facilitate initial policy enactment.

In multiple cases, incumbents underestimated the disruption that new technologies would pose to their business models, such that they choose not to expend their political capital on fighting these new entrants. This helps explain why “regime resistance” (Hess 2014; 2016) tended to lag the initial policy enactment, especially in the US where renewable policies are simply “layered” onto existing policy (Laird, 2016). This dynamic is seen most clearly in the cases of net metering and solar PV, which many utilities failed to actively resist, as well as corn ethanol, which was initially seen as a small-scale, grassroots industry with little potential to displace petroleum. As these technologies scaled up, however, incumbent industries began to resist the policies and expend more effort in lobbying and lawsuits. The increasing cost of these policies also led to greater political pushback.

In other cases, policymakers overestimated the speed with which new technologies could be commercialized, or underestimated the cost. This facilitated the enactment of overambitious mandates at a very early stage of technology development. This is seen in the case of the ZEV mandate in California, as well as the cellulosic biofuel portion of the 2007 RFS. Both policies were ultimately scaled back.

5.2. Omnibus energy legislation provides windows of opportunity and political cover

Our cases largely agree with the conventional wisdom that high-profile events—including spikes or crashes in commodity markets, acute environmental problems, and the financial crisis—drive the energy policy agenda in the U.S. (Grossman, 2013; Carlisle et al., 2016). These crises thrust energy onto the agenda and created windows of opportunity for major policy reforms. Our cases further show that, during these windows, renewable energy provisions were often added to complex energy bills and policy packages. The omnibus bills provided a political vehicle for renewable energy policies that were not salient or popular enough to independently make it onto the agenda. Moreover, the high-profile, politically controversial items attracted much of the political attention and lobbying, providing political cover for lower-profile renewable provisions.

At the federal level, major energy and air quality legislation provided opportunities for solar, wind, biofuel, and EV policies in 1978, 1990, 1992, 2005, and 2007. At the state level, electricity restructuring provided opportunities for RPS policies, and the California ZEV mandate was a small provision added into an overall vehicle emissions program. These renewable energy policies were often added towards the end of the policy formulation processes. For example, little time was spent on designing or debating the PTC when it was passed as part of a large energy bill in 1992, or the ITC when it was passed in 2015. Instead, the debate centered on more controversial issues, including ANWR drilling and vehicle fuel economy standards. Similarly, EV tax exemptions were also late additions to omnibus bills. This dynamic leads to more support than would be expected given these new industries' political influence. To make them even more palatable, the initial policies often included limits, such as funding caps or sunset provisions.

Thus, unlike in many European countries where renewable advocates pushed for comprehensive energy transition programs, in the US important renewable energy policies started off as minor additions within crisis-driven omnibus energy bills. This pattern, which might be called “policy opportunism,” may be one reason that energy transition policies in the US are pursued piecemeal through institutional layering, and also helps explain why these policies can be initially enacted without major resistance.

5.3. Policy incrementalism

Once initial policies were enacted and implemented, renewable energy policies tended to grow incrementally. At both the state and federal level, additional policies were layered on to help facilitate growth in these sectors. For example, net metering laws at the state level were followed by interconnection standards and the federal ITC, leading to a growth in solar PV deployment (Carley, 2011). The EV case shows similar layering between regulations and tax incentives at both the state and federal levels.

Many of the policies, particularly the tax policies but also the ZEV mandate, had sunset provisions or expiration dates. In most cases, these policies were extended over time. One reason is that by the time they were to expire, new entrant low-carbon industries had grown and gained political power . This pattern is especially vivid for the PTC, ITC, and the various biofuel and EV tax incentives. But compared to fossil fuel tax credits that lack sunset provisions to bring them back up for debate every few years, low-carbon technologies have suffered through much greater policy uncertainty, with some periods where incentives lapsed entirely.

5.4. Increasing politicization as mature technology threatens incumbents

After an initial period of policy incrementalism, renewable energy policies often became more controversial over time. New technologies grew to the extent that they threatened incumbents, giving rise to more active regime resistance. The growing scale of renewable deployment also led to escalating costs. Consequently, polices driving the US energy transition become more controversial, with opponent interest groups, fiscal conservatives, and consumer groups seeking to repeal policies. To understand the politics of energy transition policies, we therefore need to consider how political support evolves with technological maturity, scale of deployment, and policy costs (Breetz, Mildenberger, and Stokes, 2017).

For example, across several states, utilities have argued that net metering customers receiving the full retail rate are being subsidized, because they are not paying for the fixed costs of using the grid (Blackburn, Magee, & Rai, 2014). Solar companies have responded that solar energy provides unpriced benefits to the electricity system, and therefore, solar panel owners are actually providing a subsidy to society. This is a difficult conflict to adjudicate. Electricity prices contain multiple costs, including for operation and maintenance of the grid; however, they do not include externality costs, nor do they fully value solar power. Similarly, electric utilities through the American Legislation Exchange Council (ALEC) have attacked RPS policies on the grounds that the government should not mandate specific technologies, with some weakening and repeal efforts proving successful (Stokes 2015b). For biofuels, tax exemptions were extended for decades while the industry was small. When opposition began to grow, biofuel supporters sought to stave off some opposition by converting the gasohol tax exemption into VEETC. But, ultimately, high costs undermined VEETC as well. As for EVs, their subsidies have also become more controversial as EV sales rise. At the state level, this resulted in recent repeals of rebate programs and the imposition of new EV taxes. At the federal level, it remains to be seen whether EV tax credits will be extended or allowed to expire. The broad pattern is clear: there is growing contestation of renewable energy policies.

6. Conclusion and Policy Implications

Transitioning the energy system away from fossil fuels is an urgent task for governments around the world. The enactment of supportive policies, including both regulations and subsidies, is needed to stimulate and enable this energy transition. This paper compared eight case studies of US energy policymaking to identify common patterns in the politics underlying these policies.

Across both sectors, we found similar sequences of policymaking. Initially, these technologies' potential was often underestimated or misunderstood. They received important boosts when policies to drive these technologies were packaged as part of complex, omnibus energy bills, which provided opportunities for enactment with reduced political scrutiny. After these policies were implemented, they were incrementally revised. In some cases, the policies were weakened or delayed in response to challenges with technology deployment. But in many cases, the policies were repeatedly expanded and extended beyond the original targets. Over time, as renewable technologies scaled up and policy costs escalated, the policies often became more politically controversial. Attacks from incumbent opponents are growing, creating partisan and public opinion polarization on renewable energy (Stokes & Warshaw, 2017). These dynamics are not confined to the US. As the energy transition has accelerated around the world, political backlash has grown (Biber, Kelsey & Meckling 2017; Stokes, 2013, 2015a).

These findings are valuable for energy analysts, policy practitioners, and advocates. By examining these policy histories, we see that many transformative policies began as relatively minor, late additions or "fine print" in larger energy bills. Rather than being a weakness, their limited scope or scale was a political asset within US policymaking. Yet this also meant that enacting supportive policies was only the first step. Policies needed to be extended and expanded over time, even as resistance grew due to rising budgetary costs and increasing threats to incumbent industrial actors. The costs of transitioning should also not be underestimated— and if they are imposed on the public, opposition may mount. Sustained advocacy coalitions that last beyond enactment into implementation and policy revisions are necessary to continue to drive the energy transition and avoid policy retrenchment. For these reasons, politics are central to understanding energy transitions.

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