



Political competition and renewable energy transitions over long time horizons: A dynamic approach[☆]



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ABSTRACT

Climate change mitigation requires sustainable energy transitions, but their political dynamics are poorly understood. This article presents a general dynamic model of renewable energy policy with long time horizons, endogenous electoral competition, and techno-political path dependence. We calibrate the model with data on the economics of contemporary renewable energy technologies. In doing so, we discover transition dynamics not present in economy-energy models, which ignore politics, or in formal political economy models, which ignore long-term technological dynamics. We show that the largest effects of partisan ideology on policy occur when the competing parties disagree on the importance of energy policy. In these cases, the less ideological party appeases the more ideological one, while the more ideological party attempts to appease the electorate. The results demonstrate that political dynamics could have large effects on the development of renewable energy and carbon dioxide emissions over time, influencing the ability of countries to reach various climate mitigation trajectories.

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1. Introduction

In the study of environmental political economy, *sustainable energy transitions* have emerged as a central topic of interest (Jacobsson and Lauber, 2006; Schwoon, 2006; Verbong and Geels, 2007; Walz, 2007; Agnolucci, 2008; Schmidt and Marschinski, 2009; Loorbach, 2010; Dangerman and Schellnhuber, 2013). To a surprising extent, such transitions have already begun in forerunner countries, especially in the case of renewable energy.¹ While the International Energy Agency predicted in the year 2000 that renewables will continue to play a negligible role in the energy economy at least until 2020 (IEA, 2000), reality has proven this pessimistic prognosis wrong. According to the World Development Indicators, in 2012 Denmark generated 48% of its electricity from non-hydroelectric renewables. In Germany, the share was 19%. Even in the United Kingdom and the United States, which have begun investing in renewables much more recently, the shares were 10 and 6%, respectively. The rapid growth rates of renewables and the policies

underpinning them highlight the importance of transitions to renewable energy as a core theme in political science.

Understanding renewable energy transitions requires paying attention to politics (Torvanger and Meadowcroft, 2011; Aklin and Urpelainen, 2013). Fossil fuels continue to dominate the energy landscape largely because of a market failure, whereby their negative externalities are not priced (Unruh, 2000). Due to centuries of industrial development based on fossil fuels, they enjoy tremendous structural advantages over less mature, sustainable alternatives such as solar and wind power. This problem of “carbon lock-in” is further compounded by fossil fuel subsidies. Therefore, government action is needed for a correction of incentives and to level the playing field (Unruh, 2002; Loorbach, 2010). Indeed, a large body of literature in public policy argues that the promotion of clean technology is a key strategy in climate mitigation (Barrett, 2009; Dangerman and Schellnhuber, 2013; Smith et al., 2014).

The problem of implementing a renewable energy transition is a dynamic one, and governments cannot tie the hands of their future successors. The problems of time-inconsistency and path dependence (see Pierson, 2000; Jacobs, 2011) are widely recognized among scholars as essential for mitigating climate change and promoting renewable energy (Kline, 2001; Sandén and Azar, 2005; Hovi et al., 2009; Laird and Stefes, 2009; Nilsson et al., 2011; Levin et al., 2012). However, government incentives to promote a renewable energy transition are still poorly understood. In particular, the literature does not present models of the long-run political dynamics of renewable energy transitions. Our

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¹ In general, sustainable energy transitions also include other changes, such as energy conservation. Our focus is on renewable energy.

goal is to present such a model and use it to sharpen the social science of sustainable energy transitions more generally.

How, then, does political competition influence renewable energy transitions over long time horizons? This article presents a dynamic model that can explain the renewable energy policies of different types of governments as circumstances change over long periods of time. The key feature of the model is the inclusion of technological learning and electoral competition between two governments. Similar to [Aklin and Urpelainen \(2013\)](#), one of the governments is ‘green’ (pro-renewables) and the other ‘brown’ (anti-renewables). The strength of ideology is defined in terms of a deviation from the cost-minimizing benchmark for renewable energy. For example, the green party is willing to incur some additional energy costs to protect the environment and mitigate climate change.

Governments accede to power through regular elections decided by a majority vote. When in power, each party formulates policy strategies dynamically, taking into account the fact that current policies influence both electoral outcomes and, thanks to technological learning, the future attractiveness of clean energy to the opposing government. Specifically, we model technological learning by assuming that the marginal cost of renewable energy capacity investment decreases with the current share of renewables in the fuel mix. Although governments cannot tie the hands of their successors, current policy decisions can shape future incentives to invest into renewable energy. Therefore, political competition between parties is an important component of strategic renewable energy policy.

To make the model realistic, we use parameter estimates characterizing the economics of energy technologies observed in the U.S. and globally, including the learning curves for wind and solar energy. The dynamic model allows us to simulate energy policy trajectories over long periods of time. In practice, we evaluate outcomes for a period of 50 years. This period is long enough for a dynamic analysis, yet not so long that a scenario analysis is virtually impossible due to unknown and unpredictable factors. Because these calibrations focus on the electricity generation, the model is best suited for an analysis of renewables in the power sector.

Our main finding is that *political competition and partisan ideology exert a powerful influence on renewable energy development when the two parties show different levels of ideological commitment*. To understand this logic, consider the case of a highly ideological green party. Such a green party is ready to make renewable energy investments at very high costs. To prevent a very costly ‘crash’ program in renewable energy development, the brown party accommodates and compromises by making modest investments into renewable energy when in office. Therefore, the green party’s strong political commitment to renewable energy, along with a willingness to impose very high costs on the society, allows it to force the brown party to compromise. Over time, these investments generate technological learning and thus reduce the cost of renewables, further contributing to the energy transition.

This logic is largely robust to endogenous elections, whereby voters consider energy issues in supporting the two political parties. While we see that public opinion about renewable energy can be a powerful incentive for the two parties, the central logic of dynamic strategies remains intact. In this regard, we reaffirm the result in [Aklin and Urpelainen \(2013\)](#) that, even if energy policy is a minor issue for the electorate, political competition is critical to understanding renewable energy transitions. At the same time, we also report the surprising result that strongly ideological parties are often more sensitive to electoral considerations than their less ideological counterparts. While this result appears counter to intuition initially, the logic behind it is powerful: a party with a strong ideological commitment to certain energy policy cannot afford to lose elections, as such a party suffers heavily from any deviations from its preferred energy policy.

These findings are significant for two bodies of literature. First, they add to the analytical study of sustainable energy transitions. There is by now a large body of detailed case studies on this phenomenon,

including impressive longitudinal studies that track policy dynamics over many decades ([Verbong and Geels, 2007](#); [Hvelplund, 2013](#); [Smith et al., 2014](#); [Rosenbloom and Meadowcroft, 2014](#)). Several scholars have also proposed both analytical ([Aidt, 1998](#); [List and Sturm, 2006](#); [Aklin and Urpelainen, 2013](#); [Millner et al., 2014](#); [Schmidt and Marschinski, 2009](#)) and computational ([Schwoon, 2006](#); [Fuss et al., 2008](#); [Schwarz and Ernst, 2009](#); [Zeppini and van den Bergh, 2011](#)) models of environmental and energy policy. What we add is a dynamic analysis that captures both political competition and technological change in one unified framework focused on renewable energy. By doing so, our model can prove useful to empirical studies of energy transitions, as it provides guidance as to how we should account for the endogeneity between policy and available technological capabilities. We also shed new light on the ways in which political competition is shaped by long time horizons and processes of path dependence, with potentially important implications for understanding transitions to renewable energy. For example, our result on asymmetric ideological preferences suggests that in two-party systems such as the United States or United Kingdom, a future pro-renewable coalition could achieve significant gains in political bargaining and competition with a less ideological opposition. In today’s American politics, where the anti-renewables coalition is itself ideologically committed, the outlook is much less bright.

The findings are also important for the growing body of literature on climate policy. In this literature, the question of domestic political incentives to enact low-carbon policies has drawn a lot of attention, with scholars emphasizing factors from public opinion ([Shwom et al., 2010](#); [McCright and Dunlap, 2011](#); [Ansolabehere and Konisky, 2014](#)) to interest groups ([Gullberg, 2008](#); [McCright and Dunlap, 2003](#)) and economic side benefits ([Rabe, 2004](#)). The decarbonization of energy is an important component of strategies to avoid long-term climate disruption. Our results show how partisan ideology, political competition, and public opinion interact in a dynamic setting over long periods of time. The relative importance and effects of these different variables are modified by dynamic strategies, and our model is flexible enough to allow scholars in various disciplines to explore the dynamic implications of their premises and frameworks.

The article is organized as follows. We first present the key elements of our model, with technical details given in the online appendix. We then present our primary analytical results on the role of political competition in renewable energy transitions over long periods of time. Before we offer a concluding discussion, where we evaluate our analysis and summarize the limitations of the dynamic model, we illustrate the substantive significance of our findings by simulating renewable energy trajectories that are consistent with climate mitigation pathways in the IPCC’s Fifth Assessment Report.

2. A dynamic model of political competition and renewable energy policy

The technical details of the model are presented in the online appendix, and here we focus on conveying the intuition behind the analysis. To summarize, we consider a model with two parties. Both parties aspire to minimize the costs of energy production, but the “brown party” additionally has an ideological commitment to fossil fuels (for example, a political party could prefer coal because party activists live in communities that depend on coal mining for livelihood) and the “green party” to renewable energy (for example, many party activists could be environmentalists). For example, in the context of American politics today, one could say that Democrats are the green party with a weak ideological commitment to renewable energy, while Republicans are the brown party with a strong ideological commitment to sustaining the fossil-fuel economy. This model of political competition allows us to evaluate the effects of ideological divergence on renewable energy transitions over long periods of time under various electoral

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