



Original research article

Who wins in renewable energy? Evidence from Europe and the United States

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ABSTRACT

The emerging transition to renewable energy, such as wind and solar photovoltaics, creates winners and losers in electricity markets. The political battle unfolds largely between incumbent electric utilities on the one hand and challenger firms such as independent power producers on the other. Here, we provide the first cross-national study of renewable energy ownership, based on an original dataset of fifty-nine jurisdictions in Europe and the United States. We find that independent power producers operating utility-scale generation dominate renewable energy capacity across electricity markets. Incumbent utilities and small producers of distributed generation hold substantially less capacity. Counter to expectations, this global trend is largely independent from two basic policy choices: the choice of support policy—feed-in tariffs versus renewable portfolio standards—and the choice of electricity market policy—liberalization versus regulation of power markets—only explain marginal effects on distributional outcomes. Rather, the resource potential of jurisdictions, relative technology prices, and the market effects of technological disruption likely account for the rise of medium-sized and large independent power producers as the dominant players in the transition to renewable energy. The transition to sustainable energy thus follows a substitution path, in which challenger firms prevail over incumbent utilities in renewable energy.

1. Introduction

New renewable energy,¹ i.e., wind and solar photovoltaics (PV), accounted for 17% of global renewable electricity generation in 2014, and is projected to grow to 42% by 2040 ([1], 412). The deployment of renewable energy contributed to the slowing growth of CO₂ emissions in 2014 and 2015 [2]. While environmentally beneficial, the emerging transition to renewable energy creates, however, winners and losers in electricity markets around the globe. The political battle has been unfolding largely between incumbent electric utilities—which dominated power markets prior to the adoption of renewable energy policy—on the one hand, and challengers such as independent power producers (IPPs) and owners of small-scale distributed generation on the other.² Who wins and loses in the rise of renewable energy technologies critically shape the political coalitions in favor or against the continued

transition toward sustainable energy [3–6]. The distribution of the benefits and costs of sustainable energy transitions affect in particular the durability of political support for such transitions [7,8]. This raises the question: Who wins in renewable energy, and why? What are the distributional dynamics of sustainable energy transitions?

This article provides the first cross-national study on renewable energy ownership in 59 power markets in the EU (18) and the US (41), covering more than 95% of both wind and solar PV capacity in the two regions.³ We find that challenger firms—specifically IPPs operating utility-scale generation (USG)—dominate renewable energy capacity in the large majority of markets. Incumbent electric utilities, by contrast, hold only marginal shares in renewable energy capacity, which contrasts with their large majority shares in total power capacity (see Fig. 3). In short, IPPs with USG generation dominate renewable energy ownership in Europe and the United States, while incumbent utilities

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E-mail addresses: ninakelsey@email.gwu.edu (N. Kelsey), meckling@berkeley.edu (J. Meckling).¹ We use “RE” to denote specifically wind and solar PV generation and capacity. We exclude other forms of generation, such as concentrating solar power and biomass, as these typically make up a small share of generation and comprehensive EU data for these technologies are not available. We also use “RE” only with reference to electricity generation, not transport fuels.² The literature defines incumbents and challengers in different ways. Here, we consider incumbents as those actors owning the large majority of generation capacity prior to the adoption of renewable energy policy (here, RPS or FIT). They thus held the greatest market power historically. As our data demonstrate, these were electric utilities; indeed, as we show in Fig. 3, utilities still retain the majority of conventional generation assets. All other actors are therefore by our definition challengers, even if they owned some conventional generation assets prior to the rise of renewable energy.³ Asset ownership is a proxy for the distributional outcomes of the rise of RE technologies in electricity markets.

partake only marginally in it. Meanwhile, distributed generation, i.e., renewable energy assets owned by small producers, is growing, but in most markets it does not rival IPP-owned USG. We thus show that the transition toward renewable energy thus far appears for the most part to be following a “substitution” pathway in which challenger actors substitute for incumbent utilities in the new technology regime (cf. [9]).

Our analysis examines policy-related as well as price and technology-related explanations of the rise of IPPs and USG in renewable energy. As regards policy, we explore whether renewable energy policy choice—feed-in tariffs (FIT) or renewable portfolio standards (RPS)—result in different ownership structures. We also examine the effect of electricity market policy—liberalization or regulation of power markets—on ownership structure. We find that both types of policy choices have only marginal direct effects on the market shares of incumbents and challengers in renewable energy. Instead, we find that resource endowments in wind, relative technology prices of wind and solar PV, and the dynamics of technological disruption are more likely to account for the rise of medium-sized and large IPPs as the dominant players in renewable energy. In outliers—markets where utilities or small producers do hold large shares in renewable energy capacity—the specific policy design, including the combination of several policy instruments, such as renewable portfolio standards with renewable energy certificates, is more likely to have shaped the distributional outcome than basic policy choice. In other words, policy helps explain outliers as opposed to the broad trend toward IPP ownership.

Our findings have implications for policy. Moving beyond comparative cases, we observe a broad trend toward the substitution of incumbent utilities by challenger IPPs in the transition toward renewable energy in the EU and the US. This raises questions on how socially desirable different transition pathways are, in particular a more disruptive substitution pathway that leads to the decline of incumbent firms and the rise of new players versus a more incremental transformation pathway that results in incumbents adapting to the new technology. The implications are far-reaching, likely shaping market structure for decades to come. While our analysis suggests that the scope for policy to shape the pathway has limits, a more explicit debate on the desirability of different distributional outcomes in energy transitions is warranted.

This article proceeds as follows. First, based on prior literature we develop expectations on the effect of policy choice on the ownership of renewable energy capacity. Second, we discuss our case selection and data collection. In a third step, we present our findings on the dependent variable, i.e., ownership structure in renewable energy capacity in Europe and the United States, and test our expectations. We also examine outlier cases. The conclusion summarizes the results and identifies the implications of our findings for the politics of sustainable energy transitions.

2. Sustainable energy transitions and distributional outcomes

The literature on transitions sheds light on the dynamics of structural industrial and technological change. It highlights conflict between incumbent firms and challenger firms as a defining feature of transformational technological change within industries [10,11]. Depending on the relationship between incumbents and challengers, scholars identify different pathways of transitions [9]. A “substitution” pathway, for instance, suggests that new entrants to the market substitute incumbent players.⁴ Research suggests this is the case in the transformation of the German electricity sector. A “transformation” pathway, instead, unfolds when incumbent players adopt the new technology and

transform themselves [12]. We build on these notions of transitions, but note that here we conceptualize challengers to include firms that existed prior to the emergence of renewable energy but held minority shares in power capacity. This definition allows us to capture the overall trend of utilities losing out to IPPs in renewable energy markets. As we discuss below, IPPs are a broad set of actors, however, which is likely to result in a range of different substitution pathways. These include more corporate-driven and more citizen-driven paths to the substitution of incumbent utilities.

Research on incumbent-challenger dynamics highlights a range of potential explanatory factors, including the industry setting, incumbent firm properties, and the nature of the challenge [13]. Here, we focus on the industry setting, in particular the institutional environment. Unlike other technological transitions, the emerging transition toward sustainable energy is driven primarily by government policy [14,15]. This raises the question whether policy choice shapes the extent to which incumbents and challengers partake in the emerging technological regime.

2.1. Policy choice and ownership distribution

An extensive body of research has examined the relationship between policy and renewable energy. This includes the question of what drives the *adoption* of renewable energy policy [16,17]. Research has found political factors such as interest groups, political ideology, ruling party, and the policies of peer jurisdictions to play a role in renewable energy policy adoption [18–22]. Studies have also identified economic and resource-related drivers of government support for renewable energy, including market structure and resource endowments [20,21]. As renewable energy deployment has grown rapidly since the early 2000s, research has started to examine the effect of different types of policies on the level of deployment [23–25]. It also analyzed how different types of power market actors, such as investor-owned versus public utilities, respond to renewable energy policy [26].

This body of literature has only begun to consider the drivers of distributional outcomes in renewable energy transformations. We identify two main assumptions on the relationship between policy choice and why challengers—here, mostly IPPs—or incumbents—here, electric utilities—dominate in sustainable energy transitions. Those suggest that the choice of (1) renewable energy support policy and (2) electricity market policy are likely to shape which actors win and lose in renewable energy markets. First, the two most prominent support instruments for renewable energy are renewable portfolio standards and feed-in tariffs [27]. Renewable portfolio standards are thought to favor deployment of USG renewables by large producers—for reasons of greater economies of scale and their ability to manage the risk attached to investments under renewable portfolio standards [24,28,25,29]. Also, portfolio standards typically directly target utilities, although those utilities can opt to meet requirements by owning plants themselves or by buying electricity from IPPs. Feed-in tariffs, in contrast, are understood to provide in particular incentives for comparatively small producers such as households and small and medium-sized enterprises [30,31,23,12]. We would, therefore, expect quotas and renewable portfolio standards to favor utility-scale deployment, while feed-in tariffs favor higher levels of DG.

Our second expectation relates to electricity market policy, i.e., whether a market is regulated or liberalized. The degree of liberalization of a market is understood to have a strong impact on market structure, with competition and monopolies at either end of the spectrum. Research has, for instance, shown that high concentration of market actors reduces the likelihood of renewable energy policy adoption [21]. Here, we extend this line of exploration to effects on ownership structure. The liberalization of electricity markets exposes incumbent utilities to competition from new entrants [32]. In fact, the historical evidence suggests that this shifts generation assets to IPPs [33]. We, therefore, expect that in regulated power markets incumbent

⁴ Our definition of substitution focuses on whether challengers come to dominate renewable energy ownership as the electricity industry shifts toward renewable energy, not on ownership of total generation capacity including legacy conventional capacity. Also, we examine only generation capacity, not shares in the retail market.

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