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RENEWABLE ENERGY TECHNOLOGY CHARACTERISTICS AND THE DYNAMICS OF NEW MARKET OPENINGS

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Motivation and content

The transformation of electricity systems towards low-carbon technologies is an increasingly globalized phenomenon. European forerunner countries with ambitious renewable energy policies such as Germany or Denmark also hoped for an international diffusion of renewables, helping to meet global climate change mitigation commitments. At the same time, dedicated green industrial policies targeted the build-up of companies and supply chains in technologies such as wind power and solar PV that can serve world markets and create jobs in their home markets.

After two decades of strong political support, renewable energy technologies diffused to most industrialized and also many developing countries. Academic research studied how global value chains interact with established renewable energy markets in individual countries. However, little attention has been given to determining how new markets for renewables are opened initially, how patterns of market openings are shaped by technology differences, and what is the role of private project developers in opening new markets. An improved understanding of market opening patterns will help to accelerate the diffusion of renewables to further countries; it is also highly relevant for the future diffusion of new, less mature low-carbon technologies, such as battery storage.

Accordingly, this contribution analyzes the dynamics of market openings for renewables. It draws on literature regarding the global spillover of knowledge and innovation for energy technologies. Empirically, we use a newly merged dataset encompassing 80 countries to assess the role of technology characteristics, local and international players. Finally, implications for policy makers are briefly discussed.

Methodology

The study considers onshore wind turbines, solar PV, and biomass/biogas combustion. These three technologies differ markedly in their requirements for localized knowledge, so we would expect to see differences in the results for each technology regarding the market opening dynamics as well as the share of international developers involved.

The study draws on two financial databases maintained by Bloomberg New Energy Finance (BNEF). The first dataset includes all utility-scale renewable energy projects globally known to Bloomberg [1]. Using the commissioning date, projects within the same country and technology are numbered according to their sequence of realization. We analyze the first projects in each of the three technologies in a country and compare the characteristics of their project developers with those of follow-up projects. In sum, 863 projects in 80 countries were identified through this analysis. Next, we match our dataset to a second BNEF database containing information on circa 60,000 organizations in the sphere of renewable energy [2]. Characteristics analyzed include the ownership type (public or private), the country of origin, as well as a description of the business areas in which a company is active. Analyses and visualizations of the resulting database are then used to empirically assess insights from knowledge and innovation theory regarding renewable energy technologies.

Results

Technology differences clearly impact the dynamics of new market openings over time. The figure below shows the year in which countries realized their first utility-scale project in the different technologies. Wind, solar and biomass differ considerably, reflecting the respective importance of global and local learning: While wind power diffused quite continuously over time, solar PV was rather introduced in a “big bang” from 2009 onwards, with 9 or more markets being opened each year during 2012–2015.

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The key components of solar plants – PV modules and inverters – are both globally traded commodities and can be applied across geographies with very little localized knowledge or adaptation required [3]. The cost of PV modules experienced a particularly large drop between 2008 and 2010, driven by deployment policies in forerunner countries (especially Germany). This technology cost reduction "spilled over" to other countries and also paved the way for the market openings in many developing countries after it became cost competitive.

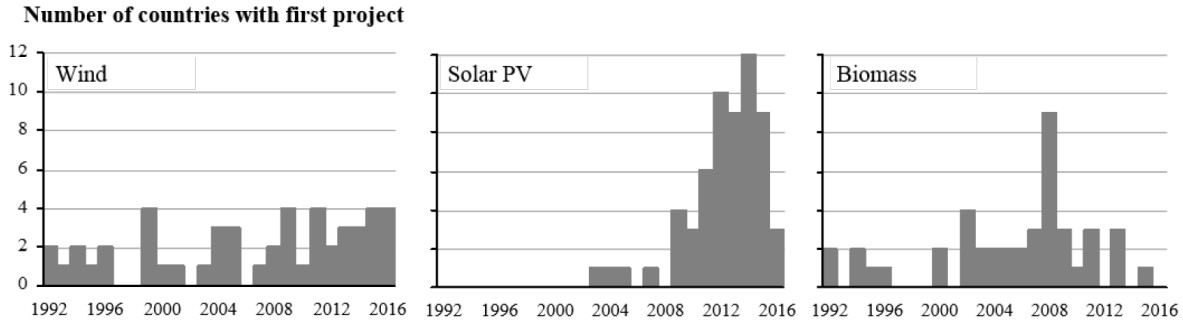

Figure 1: Wind, Solar PV, Biomass

In contrast, wind power does not exhibit a pronounced peak in deployment, despite also achieving significant cost reductions over time. Although wind turbines themselves are supplied a few leading global manufacturers, the development of a wind farm requires a higher degree of engineering design and greater complexity in procurement and construction, which tends to be localized knowledge [4]. Also turbines have to be adopted to local conditions (wind classes). Hence, for wind global learning curves are relatively less important than for PV.

Finally, the conversion of biomass to electricity can utilize a broad set of combustion concepts developed in different regions, driven by different types of predominant biomass feedstock. Consequently, biomass power plants often need to be tailored to specific sites and thus their deployment typically requires substantial localized knowledge. Hence a rather continuous diffusion over time to new countries could be expected. However, a considerable peak in market openings occurred in 2008, driven by 7 projects developed under the Clean Development Mechanism (CDM) which could be used to offset emissions in countries with emissions reduction obligations under the Kyoto Protocol, and were accepted in the EU emission trading system since 2008. Under the CDM, biomass projects were particularly attractive due to their avoidance of methane, a greenhouse gas 20–30 times more powerful than CO_2 and thus more revenue-generating under the crediting mechanism.

Beyond showing different dynamics over time, further analyses underlined that the three technologies differ considerably concerning which project developers typically open new markets. For solar PV, international private developers are highly relevant, as they can draw on tacit knowledge accumulated by realizing projects in other countries. In contrast, biomass plants are often developed by local companies in adjacent businesses that produce the feedstock, (e.g. agriculture, pulp and paper). For wind, the share of international developers is in between the other technologies (solar PV: 61 %, wind: 58 %, biomass: 33 % – always referring to privately developed first projects). Overall, the study suggests to keep the different technological characteristics of renewable energy technologies in mind when designing renewable energy policies that (also) aim at international diffusion.

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