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ASSESSING THE DISRUPTIVE POTENTIAL OF NEW TECHNOLOGIES IN
THE EUROPEAN ENERGY MARKET

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Overview

The European Union and numerous countries in the world foster the transformation of the energy sector to follow a more sustainable pathway. Most of the countries have introduced measures to increase the share of renewable energies and, thus, to support the development and diffusion of new alternative energy technologies for electricity generation, heating and mobility. Specifically in the power generation sector, energy technologies such as solar photovoltaic (PV) and wind power have perceived high growth rates in several European countries, and in particular in Germany and Spain. The share of renewable energies in the gross national electricity consumption in Germany, for instance, has reached 25% by the end of 2013 (BDEW, 2014) (27% in the first quarter of 2014; BNEF, 2014). The strong and fast rise of renewable energies, however, has a disruptive impact on energy markets in form of structural changes, new market entrants, decreasing wholesale prices, increasing retail prices, changing consumer needs and new offerings to fulfil these needs. In the forefront of the discussions is the disruptive potential of solar PV due to its advantage of easy-to-install, decentralized possibility to generate power where it is needed, the sharp decline in system costs and the advances in small-scale storage technology (Frankel, Ostrowski, & Pinner, 2014). Large energy incumbents are hit strongly by these developments and struggle with declining profits and market capitalization (The Economist, 2013). Most of them missed to properly position themselves with new offerings and business models at an earlier stage of this market change. The reasons for this are manifold and firm specific but one important pitfall was that most of the incumbent market players did not adequately assess and interpret the disruptive potential of the new energy technologies.

Thus, the question arises how energy companies and other actors such as policy makers and non-governmental institutions could determine the disruptive potential of new technologies in the energy markets at an early stage of technology development. Research in this area shows that the diffusion of new energy technology, and thus also its disruptive potential (Christensen, 1997), is not only dependent on technology-related factors such as the rate of efficiency increase but also social acceptance-related (Wüstenhagen et al., 2007), social and behavioural consumer-related factors (Adner, 2002). We build on previous research in this area (e.g. Bergek et al., 2013; Govindarajan & Kopalle, 2006) and developed a framework to assess the *ex-ante* disruptive potential of new energy technologies. We applied and validated this framework by assessing the disruptive potential of five renewable energy technologies (wind energy, solar energy, biomass, hydro power, geothermal) in the power generation, heating and transportation sectors of four European countries (Austria, Bulgaria, Germany and Romania). Our results show the applicability of the framework and give insights into technology and country specific determinants of energy market sector disruptions.

Methods

Our methodological approach consists of two steps. First, we conducted a thorough review of the literature in the fields of (disruptive) innovation, technology diffusion and social acceptance and based on previous work in this field we developed a framework to *ex-ante* measure the disruptive potential of new energy technologies. This integrative framework assesses disruptiveness along five main dimensions: (1) market share development (past and expected annual growth rates), (2) value proposition (consumer perspective), (3) time to market (stage of technology development), (4) learning rate (technology learning curve in terms of cost/capacity installed), and (5) diffusion barriers (technological, financial, political and social).

Second, we conducted an empirical test of the framework on five renewable energy technologies (wind energy, solar energy, biomass, hydro power, geothermal) in the power generation, heating and transportation sectors of four European countries (Austria, Bulgaria, Germany and Romania). All technologies were assigned ratings from 1 (low) to 5 (high) on how they performed in the dimensions and sub-dimensions in the specific market sectors based on qualitative and

quantitative information. The overall disruptiveness factor is determined by the average of the individual ratings. Qualitative and quantitative data (e.g. investment in different financial sectors and capacity installed per renewable energy technology) has been gathered through an extensive desk research, databases (e.g. Bloomberg New Energy Finance) and 30 semi-structured interviews with experts from international and national research institutions, government agencies and energy companies.

Results

Our findings show that the disruptive potential of the renewable energy technologies in our study varies between technologies and geographical markets. Technological barriers, learning rate and time to market are technology specific, even though highly influenced by national investments in R&D and other support mechanisms (socio-political acceptance and political barriers) and consumer demand (perceived value proposition and consumer acceptance).

In the electricity sector, for instance, our results show that in all geographical markets, wind power and solar PV have the highest disruptive potential. Germany is the only market in our sample of countries that already experiences major market disruptions due to the massive increase of these new energy technologies. In Austria, for instance, solar PV has increased 500% in the past 3 years but still only holds a 1% market share (PV Austria, 2013). Main diffusion barriers at the moment are related to regulation and policy support as well as the level of retail electricity prices.

Conclusions

The challenges in the energy industry show the importance of *ex-ante* assessing the disruptive potential of new technology in the energy market sectors. Our work shows the applicability of the developed framework for measuring *ex-ante* market disruptions in the energy sector and gives detailed insights into the development and diffusion of several energy technologies in four European markets.

The findings of our study can serve as a basis for strategic decision-making of governments and governmental institutions, energy technology manufacturers, energy companies, non-governmental organizations, etc. Energy incumbents can specifically use and integrate this framework and its indicators in a market and technology monitoring system to better understand and predict the disruptive potential and probability of different new energy technologies.

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