Energy Economics 39 (2013) 187–196

Contents lists available at SciVerse ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Market power in renewable portfolio standards

Makoto Tanaka [a], Yihsu Chen [b,*]

[a] National Graduate Institute for Policy Studies (GRIPS), 7-22-1 Roppongi, Minato-ku, Tokyo 106-8677, Japan
[b] School of Social Sciences, Humanities and Arts, School of Engineering, University of California - Merced, 5200 N. Lake Rd., Merced, CA, USA

ARTICLE INFO

Article history:
Received 8 August 2012
Received in revised form 2 May 2013
Accepted 4 May 2013
Available online 14 May 2013

JEL classification:
L13
L94
Q28
Q48

Keywords:
Market power
Renewable portfolio standards
Renewable energy certificates/credits
Dominant firm-competitive fringe

ABSTRACT

Renewable portfolio standard (RPS), which requires a certain percentage of electricity production from renewables, has received considerable attention. One emerging issue is the possibility of strategic behavior in the renewable energy certificate/credit (REC) market, and its spillover effects on the electricity market. This paper develops dominant firm-competitive fringe models that account for market power. We show that market power could have significant impacts on the REC and power prices. In particular, when a nonrenewable generator is a dominant firm and a renewable generator is a competitive fringe, the nonrenewable firm has a strong incentive to lower the REC price, even to zero for avoiding REC costs. The zero REC price would negate price impacts in the power market, thereby mitigating market power of the dominant firm. However, this could lead to an underinvestment in renewables in the long run as subsidies received by renewables in form of RECs vanish. Therefore, regulatory agencies need to carefully oversee the market performance to ensure a healthy development of renewable industries under the RPS policies.

1. Introduction

As climate change becomes evident, numerous resources and policies have been devoted to promoting renewable energy or controlling greenhouse gas emissions (GHG) from the power sector and other energy-intensive sectors. One of the challenges faced by the renewable investors is how to secure up-front capital for renewable projects. Because benefits associated with renewable energy cannot be fully reflected by market prices, governmental interventions become essential to promote renewable energy in competitive marketplaces. One of the policies that is commonly implemented by many states in the United States is renewable portfolio standard (RPS). RPS mandates a certain percent (or a MWh amount in some states) of electricity generation to be from renewable sources. The point-of-regulation under RPS is generally on load serving entities (LSEs). In some states, there are more than one way of meeting the RPS requirement: self-generation, procuring power from renewable sources via bilateral contracts and purchasing the renewable energy certificates/credits (RECs) from secondary markets. In this sense, RPS and REC can be seen as an analog of tradable permits or allowances in cap-and-trade (C&T) programs; although, RPS/REC and C&T have different mechanisms and features.

One emerging issue that has received relatively little attention is the possibility of market power associated with renewable energy. Conventional and incumbent nonrenewable generators usually have a large share in the electricity markets, and tend to have market power on electricity prices. These incumbent generators might also have the ability to exert market power in related markets such as the tradable permit markets and REC markets. On the other hand, there could be some cases where emerging renewable generators have market power in these markets. There are at least three concerning factors. First, limited locations that are suitable for developing renewable energy, e.g., wind, might have already be owned or contracted by a few firms. Second, firms might possess technology patents or own exclusive rights to use certain technologies of renewable energy that could effectively prevent their rivals from engaging in the markets. Third, some firms might be familiar with permit application process, e.g., environmental impact assessment, or already have contracted with experienced workforces. All of these could lead to a market with high concentrations of renewable ownership.

The issue of market power in the renewable energy market is especially crucial as some states had committed in ambitious RPS targets, e.g., 33% by 2020 in California. The effect of market power in the REC market can spillover to the electricity market. For example, withholding renewable output could limit the amount of energy that can be produced by nonrenewable energy under the RPS requirement, effectively driving up electricity prices. In a sense, RECs can be used by dominant firms as tradable permits in C&T programs to

* Corresponding author. Tel./fax: +1 209 228 4102/4047.
E-mail addresses: mtanaka@grips.ac.jp (M. Tanaka), yihsu.chen@ucmerced.edu (Y. Chen).

0140-9883/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.eneco.2013.05.004

exercise market power in the electricity markets. Empirical analysis of the 2000–01 power crisis in California suggests that a large generator puts a cost-squeeze on other firms by intentionally consuming more permits than necessary, raising permit costs for other companies that were short of permits (Kolstad and Wolak, 2008). Permit shortages and high permit prices were reasons offered by some generators for their inability or unwillingness to generate power in the waning months of 2000. Therefore, as an analog of tradable permits in C&T programs, the market power in the REC markets could also be concerning.

Hahn (1984) is the first to theoretically study the market power problem in a tradable permit system, by using a dominant firm-competitive fringe model.[1] His model assumes market power in the permit market, without explicitly considering the product market. He demonstrates how a single dominant firm can manipulate the permit price to its own advantage, which reduces the cost-effectiveness of a tradable permit system. Misiolek and Elder (1989) extend Hahn's market structure to the product market, and investigate the interaction with the permit market. They show that a single dominant firm manipulates the permit market in an effort to drive up the fringe firm's cost in the product market. Eshel (2005) discusses the optimal allocation of tradable emission permits within a dominant firm-competitive fringe model as in Misiolek and Elder.

In contrast with the literature on tradable permits in the C&T markets, the concept of RPS and REC is relatively new, and the market power problems in RPS and REC have not been fully investigated in literature. In this paper, our primary focus is on applying dominant firm-competitive fringe models to the RPS/REC system in order to examine the market power problems. Our intention here is to explore the possibility that market power could be a concern in RPS-implemented markets. We develop a general model in which a dominant firm can manipulate the product, i.e., electricity, and the REC prices in its favor through a competitive fringe firm. In particular, the first-order condition associated with the fringe's problem and the market clearing condition for REC are explicitly included as the dominant firm's constraints. Mathematically, the market clearing condition for REC is expressed as a complementarity condition, and the dominant firm's optimization problem is formulated as Mathematical Program with Equilibrium Constraints (MPEC). Furthermore, our models can be seen as an extension of Fischer (2010), which considers perfect competition for both power and REC markets. In this paper, we extend the paper of Fischer (2010) by allowing firms to exercise market power in both markets.

The paper has the following findings. First, when a nonrenewable generator is a dominant firm and a renewable generator is a competitive fringe, the nonrenewable dominant firm tries to raise the electricity price, while pushing down the REC price. The REC price can even become zero in some cases, beyond which the nonrenewable dominant firm cannot manipulate the REC prices further. In other words, the ability of nonrenewable dominant firm to exercise market power is limited when the REC prices crash to zero. However, from a long-term point of view, a zero REC price could have a negative impact on the profits of renewables, leading to an underinvestment in renewable generation in the long run. Second, when a renewable generator is a dominant firm and a nonrenewable generator is a competitive fringe, the renewable dominant firm tries to raise both power and REC prices at the same time. High level of REC price could also distort investment incentives, resulting in inefficient resource allocation for power generation in the long run. Therefore, cautious regulatory oversight is necessary for a healthy development of renewable industries when implementing the RPS policies.

The remaining of the paper is organized as follows. In Section 2, we give the background information on RPS in US. Section 3 provides a brief literature review on the studies related to the RPS policies. Section 4 presents the dominant firm-competitive fringe models for product and REC markets. We then apply our theoretical models to simple numerical studies in Section 5. Section 6 contains the concluding comments.

2. Background on RPS policies in the US

As of 2012, a total of twenty nine states and the District of Columbia have RPS. The eligible sources, the targeting years and the levels of the RPS requirements vary by states, reflecting the aggressiveness of the state policies and the types of renewable sources that states possess (Bird and Lokey, 2007). For example, while hydropower with a capacity greater than 25 MW does not qualify in most states, it is eligible under Maine's RPS program. California has a binding RPS of 33% by 2020, compared to Arizona's target of 15% by 2025. Some RPSs have tier structures, which would favor certain technologies: class I technologies under the New Jersey RPS include solar, wind, tidal wave, geothermal, etc. (DOE, 2008). In some states, RPS is a non-binding policy (e.g., North Dakota, 10% by 2015). The REC prices vary significantly by states (Wiser and Barbose, 2007), reflecting the factors discussed above.

Another issue that might have significant implications for the REC prices and welfare distribution is whether the RPS programs would allow RECs from other states to be used by LSEs to meet their renewable target. Under the California RPS rules, REC produced elsewhere within the western grid can be unbundled and used by LSEs within the California territory to meet the RPS requirements (CPUC, 2012). This can lower the compliance costs of meeting state RPS, thereby reducing the REC and power prices.[2] Supplementary policies, such as public benefits funds for renewables, property tax incentives for renewables, net metering policies, load programs for renewables, and etc., also coexist with RPS.[3]

3. Literature review on RPS

This section provides a brief literature review on the studies concerning RPS/REC.[4] Bird and Lokey (2007) and Bird et al. (2008) summarize the key issues of how renewable energy markets might interact with carbon regulation, including the implications for emissions benefits claims, voluntary market demand, and the use of RECs in multiple markets (e.g., double-counting). Mozumder and Marathe (2004) give an overview of RPS and discuss the benefits of integrated RECs markets. Gillenwater (2008a, b) explains various challenges when using RECs to offset pollution emissions (e.g., additionality). Holt and Wiser (2007) summarize the treatment of renewable energy attributes in the state RPS rules, and address a number of crucial issues for implementing successful policies. These include a well-functioned certificate tracking system, a well-developed definition of renewable attributes, and a careful consideration of how the emission credits produced from renewables are evaluated when a permit trading is concurrently implemented.

Several studies examine the REC markets qualitatively and quantitatively. Amundsen and Mortensen (2001) formulate a simple static equilibrium model for the electricity market taking account of both RECs and tradable emission permits, and show several comparative static results in the short and long run. Jensen and Skytte (2002)

[1] See, for example, Montero (2009) and Tietenberg (2006) for a detailed discussion of the market power problem in a tradable permit system.

[2] See, for example, Chen and Wang (in press), which discuss the effect of RECs unbundling in the REC and power markets.

[3] For more detailed information about these policies, see the Database of States Incentives for Renewables and Efficiency (2012). In fact, competing climate or energy policies has been a concern. For example, on May 26, 2011, the governor of New Jersey announced his intention to withdraw from the Regional Greenhouse Gas Initiative (RGGI), which is a cap-and-trade program, arguing that (1) RGGI's permit price is too low to induce behavior changes, (2) the state of New Jersey has already met its 2020 emission target, and (3) other existing state renewable policies have already provided significant incentive for emission reduction. However, aforementioned renewable policies are actually types of subsidies that would directly lower production costs of renewables.

[4] In the literature, REC is also called tradable green certificate (TGC).