Viewpoint

Renewable portfolio standards and cost-effective energy efficiency investment

A. Mahone[a], C.K. Woo[a,b*], J. Williams[a], I. Horowitz[c]

[a] Energy and Environmental Economics, Inc., 101 Montgomery Street, Suite 1600 San Francisco, CA 94104, USA

[b] Hong Kong Energy Studies Centre, Hong Kong Baptist University, Hong Kong

[c] Warrington College of Business, University of Florida, Gainesville FL 32611-7169

Abstract

Renewable portfolio standards (RPS) and mandates to invest in cost-effective energy efficiency (EE) are increasingly popular policy tools to combat climate change and dependence on fossil fuels. These supply-side and demand-side policies, however, are often uncoordinated. Using California as a case in point, this paper demonstrates that states could improve resource allocation if these two policies were coordinated by incorporating renewable energy procurement cost into the cost-effectiveness determination for EE investment. In particular, if renewable energy is relatively expensive when compared to conventional energy, increasing the RPS target raises the cost-effective level of energy efficiency investment.

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* Corresponding author

Phone: 415-391-5100, Fax: 415-391-6500

Email address: ck@ethree.com (C.K. Woo)

1. Introduction

Renewable portfolio standards (RPS) and mandates to invest in energy efficiency (EE) are increasingly popular policy tools to combat climate change and dependence on fossil-fuels.[1] Twenty-three U.S. states and Washington D.C. have mandatory RPS, requiring that a fixed percentage of a utility's retail sales are met with renewable energy (www.dsireusa.org).[2] Likewise, 18 states have established, or are currently working to establish, similar policies for energy efficiency, known as Energy Efficiency Resource Standards (EERS) (Eldridge et al., 2008). EERS policies typically require that a utility procure a fixed percentage of its forecasted load from energy efficiency.[3]

State EE policy targets do not imply unlimited EE spending. The state regulator, typically a public utility commission (PUC), establishes a cost-effectiveness criterion for EE investment. The PUC approves funding for an EE program (e.g., financial incentives for buying compact fluorescent lights) if the program's implementation cost is shown to be less than the avoided supply costs (e.g., generation, transmission, and sometimes environmental costs) (EPA, 2007; Baskette et al., 2006). Even though EE investments reduce retail sales and aid RPS compliance, the cost-effectiveness tests used by a state's PUC do not consider that the avoided supply cost of EE often depends on the cost of procuring renewable energy, as well as conventional generation.

[1] The use of RPS as a policy tool in the U.S. remains controversial. Related research has investigated whether a federal RPS is necessary (Ralls, 2006), whether a federal RPS is preferable to state-level RPS policies (Cooper and Sovacool, 2007), how successful states have been at achieving and enforcing compliance with RPS policies (LBNL, 2008), and whether feed-in tariffs are preferable to other mechanisms, such as tradable credits, for meeting RPS targets (Rickerson and Grace, 2007).

[2] Texas and Iowa have RPS targets that require the state to build a fixed amount of renewable energy capacity by a certain date. Since these RPS targets do not vary with retail sales, they do not depend on EE investment that aims to reduce retail sales.

[3] Hawaii, Nevada, and Pennsylvania have a combined EERS-RPS standard, allowing either EE or renewable energy to count towards the target (LBNL, 2008).

Using California as a case in point, this paper demonstrates that states could improve allocation of resources if these two policies were coordinated by incorporating the renewable-energy procurement cost into the cost-effectiveness determination for EE investment. In particular, if renewable energy is relatively expensive when compared to conventional energy, increasing the RPS target raises the cost-effective level of energy-efficiency investment.

2. Energy Efficiency and the Avoided Cost of Generation

To see how the marginal cost of renewable energy may affect the cost-effectiveness tests for EE, consider the marginal cost of procuring 1-MWh of electricity to meet a state's load growth, which is the per MWh cost that can be avoided by 1 MWh of EE savings. The avoided procurement cost depends on the state's resource mix, as demonstrated by the following three cases under the assumption that renewable energy is relatively more costly than conventional energy.[4]

- ***Case 1: A state's installed renewable energy exceeds the RPS target.*** Since RPS compliance is not a constraint on the state's procurement plan, the marginal procurement cost should be the per MWh cost of the least expensive resource. If the 1-MWh incremental electricity requirement is to be met by *new* combined-cycle natural-gas turbine (CCGT) generation, the avoided procurement cost of EE is the per MWh all-in cost of building and operating new CCGT generation.[5]

[4] Should renewable energy be less costly than conventional energy, the need for RPS to promote renewable-energy development would greatly diminish. As will be shown below, the marginal cost of California's renewable energy can far exceed the marginal cost of conventional energy.

[5] This all-in cost includes the O&M cost, fuel cost, and return on and of investment for a generation owner (Orans et al., 2004).

- ***Case 2: A state's installed renewable energy is short of the RPS target.*** This case is best illustrated by a simple example that assumes total retail sales of 100 GWh and an RPS target of 33%. Absent EE investment, the renewable-energy requirement is 33 GWh (= 0.33 * 100 GWh). A 10-GWh reduction of retail sales via EE investment implies that the renewable-energy requirement declines to 29.7 GWh (= 0.33 * (100 GWh - 10 GWh)). Thus, the avoided renewable energy is 3.3 GWh (= 33 GWh - 29.7 GWh) and the avoided conventional energy is 6.7 GWh (= 10 GWh - 3.3 GWh). When both the marginal renewable energy and marginal conventional energy come from newly-built generation, the avoided cost of EE is the RPS-weighted marginal cost of *new* renewable energy and *new* CCGT generation.
- ***Case 3: A state's installed renewable energy tracks the RPS target.*** This case reflects a state's long-run procurement trend when the state is required to maintain an RPS target over many years, meeting a fixed percentage of its new load growth with renewable energy. In this case, the RPS target sets the percentage of the incremental energy requirement that must be met with renewable energy, while the remainder is met with conventional generation. Thus, the avoided cost of EE is the RPS-weighted marginal cost of *new* renewable and *new* CCGT generation, which is the same as Case 2.

3. RPS and Cost-effective Energy Efficiency in California

California is a timely and relevant case study to illustrate the implications of the effect of an RPS on the cost effectiveness of EE, because the state is currently considering raising both its RPS and its EE savings targets to comply with the California

Global Warming Solutions Act of 2006 (Assembly Bill 32). Currently, the state requires that the investor-owned utilities (IOU) procure 20% of their retail sales from renewable energy by 2010. The California Air Resources Board (CARB), tasked with implementing Assembly Bill 32, has proposed increasing this RPS to a statewide 33% target by 2020.[6] They have also set an EE target of at least 32,000 GWh by 2020 (CARB, 2008). This EE target, however, is not based on a cost-effectiveness analysis of EE investment in the presence of RPS.

The CARB is not alone in overlooking the likely effect of RPS on EE cost-effectiveness determination. Consider the California Public Utilities Commission's (CPUC) adopted avoided-cost calculation of energy efficiency. The calculation is detailed, accounting for the all-in cost of new CCGT generation, the geographically varying cost of new transmission and distribution capacity, marginal line losses, as well as adders for price sensitivity of demand and environmental externalities (Baskette et al., 2006). However, it does not recognize that marginal procurement costs can be RPS-dependent, as demonstrated in Section 2 above.

To see how California's RPS target may affect cost-effective EE investment, consider Figures 1 and 2. Figure 1 represents California's marginal cost curve for electricity, capped by the new CCGT's cost of approximately $94/MWh for meeting demand growth, at an assumed natural-gas price of $7.85/MMBTU.[7]

Figure 2 portrays California's high and steep marginal costs for new renewable energy, when compared to the marginal cost curve in Figure 1. The costs in Figure 2

[6] The 33% RPS policy is supported by the state regulatory commissions' decision (CPUC 2008b) and the Governor's November 17, 2008 Executive Order D-14-08.
[7] The marginal costs of generation of existing resources and the all-in cost of new CCGT are derived from data used in the "GHG Calculator" publicly available at: http://www.ethree.com/cpuc_ghg_model.html.

represent the all-in levelized per MWh costs of constructing and delivering new renewable energy to the California grid. They are area-specific because of geographic differences in potential and access.[8] For example, wind energy at Tehachapi is less costly than the average cost of wind energy elsewhere in the state. The curve reflects a plausible resource mix for achieving the state's current 20% RPS target and proposed RPS target of 33% of retail sales by the year 2020. The curve in Figure 2 shows marginal costs of renewable energy from $117/MWh at the 20% target to $171/MWh at the 33% target. Thus, the marginal cost of conventional generation is currently less than the all-in cost of new renewable energy. Rising natural-gas prices and policies that add a carbon price for greenhouse gas emissions could, however, make conventional generation more costly than renewable energy.

Using Figures 1 and 2, we compute the state's marginal procurement cost for meeting a 1-MWh incremental electricity requirement. Since the state's installed renewable generation is currently below the RPS target, Case 1 is not applicable to our marginal cost calculation.[9] Hence, the marginal procurement cost should be based on Case 2 or 3, which is the RPS-weighted average of marginal costs for new generation.

To comply with the 20% (33%) RPS target, the 1-MWh incremental electricity requirement is to be met by 0.20 (0.33) MWh of *new* renewable energy and 0.80 (0.67) MWh of *new* CCGT. Hence, the marginal cost at the 20% RPS target is $98.6/MWh (= 20% x $117 + 80% x $94); and at 33% it is $119.4/MWh (= 33% x $171 + 67% x $94).

[8] The renewable-energy resource cost and assumptions underlying Figure 1, which are based on a study commissioned by the CPUC and CARB, are described at: http://www.ethree.com/cpuc_ghg_model.html.
[9] In California, as of 2007, renewable generation comprised approximately 12.7 percent of the IOUs' total retail sales. The IOU's RPS attainment has been actually declining since 2003, as load growth outpaces renewable-energy development (CPUC, 2008a).

Thus, raising the RPS target from 20% to 33% could raise the state's avoided marginal cost of electricity by 21.1% = ($119.4 – $98.6)/$98.6.

This would indicate that currently, in California, more EE investment should be deemed cost-effective than in the past, when natural-gas generation was always the marginal new source of energy. Based on the per kWh cost of achieving electricity savings in California via EE investments in 2016 (ITRON 2008, p.B-2, p.B-15), if the marginal procurement cost increases from $98.6/MWh to $119/MWh, about 1,000 GWh of additional saving could become cost effective in California's two largest investor-owned-utility service territories.[10] To put this number in context, 1,000 GWh could meet the electricity needs of about 100,000 homes, assuming an average residential home consumes 10 MWh per year (EIA, 2001).

3. Conclusion

The California example illustrates the importance and relevance of using an RPS-dependent avoided-cost estimate to establish the cost-effective level of EE investment. Given the prevalence of state RPS targets, and given that renewable energy remains more expensive on a $/MWh basis than conventional generation in many parts of the country, energy efficiency should play an expanded role in achieving a least-cost supply of clean and sustainable electricity. While other states may not adopt the aggressive RPS targets under consideration in California, they may find it useful to apply the approach proposed herein to quantify the RPS-dependent marginal costs, which will likely improve EE's cost-effectiveness.

[10] The 1000 GWh estimate does not consider other avoided-cost components (e.g., line loss, transmission, distribution and externalities). A complete cost-effectiveness analysis, however, is beyond the scope of this paper.

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Marginal cost

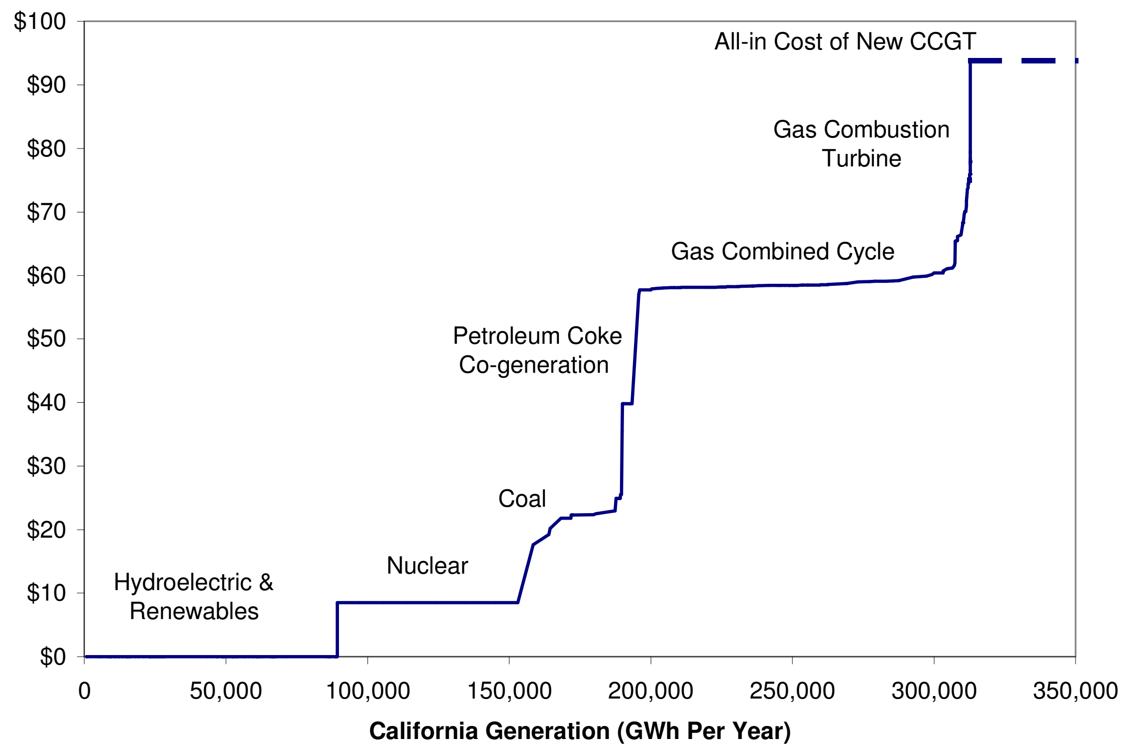

Figure 1: Marginal cost of ***existing*** generation in California, capped by the all-in cost of a ***new*** combined-cycle natural-gas turbine (CCGT). The lowest portion of this curve portrays the existing must-run hydro and renewable resources that have zero variable costs. The marginal costs of other existing resources such as nuclear, cogeneration, gas-combined-cycle and gas-combustion turbine are these resources' per MWh variable costs. (Source: Authors' calculations, based on data from a study commissioned by the California Public Utilities Commission and California Air Resources Board, described at: http://www.ethree.com/cpuc_ghg_model.html).

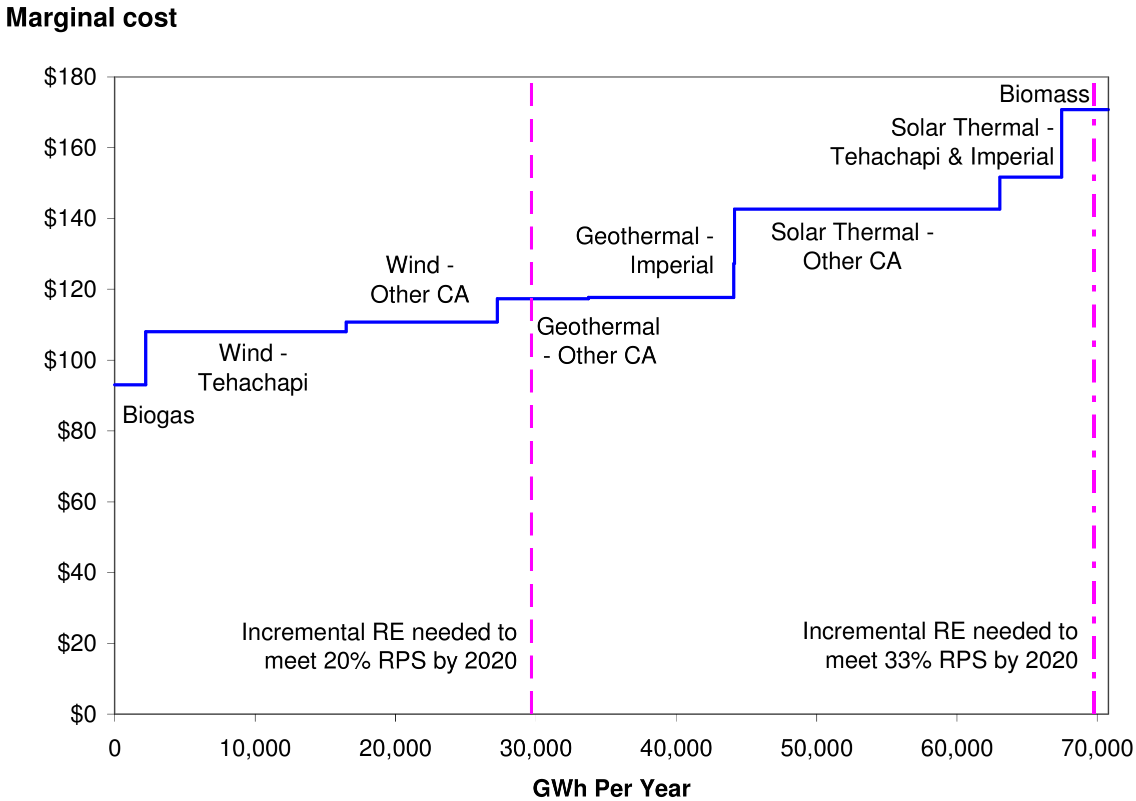

Figure 2: All-in per MWh costs of ***new*** renewable energy for meeting California's 20% RPS and proposed 33% RPS target by 2020 assuming business-as-usual load growth and energy efficiency. The all-in per MWh cost of each ***new*** resource includes generation capacity costs, variable costs, and transmission costs for inter-connection and delivery. (Source: Authors' calculations, based on data from a study commissioned by the California Public Utilities Commission and California Air Resources Board, described at: http://www.ethree.com/cpuc_ghg_model.html).