Capturing the Benefits of California's Energy Infrastructure Investments

by

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1. Introduction

My name is Frank Wolak and I am the Holbrook Working Professor of Commodity Price Studies in Department of Economics and the Director of Stanford's Program on Energy and Sustainable Development at Stanford University. From January of 1998 until April of 2011, I served as Chair of the California Independent System Operator (ISO) Market Surveillance Committee (MSC). The MSC is an independent market monitoring entity for the California electricity market. The MSC's responsibilities include providing comments, critiques, and recommendations on the ISO market design and monitoring processes and other market issues of interest to the ISO Chief Executive Officer and Board of Governors. In addition, the Committee is required under the ISO tariff to review and comment on Department of Market Monitoring analyses and reports. The reports and opinions written by the MSC are available on the California ISO web-site.

I have been asked to provide an assessment of the current state of energy industry regulation in California. First, I will discuss the regulatory changes implemented to address the California Energy Crisis in order to answer the question of whether appropriate safeguards are in place to prevent a future crisis. I will then describe the challenges to California's energy regulatory policies associated with meeting its current energy and environmental goals using the existing energy infrastructure. Finally, I will suggest regulatory policy changes that could significantly increase the economic and environmental benefits accruing to the citizens of California.

2. Policy Changes in Response to California Electricity Crisis

The major causes of the California Electricity Crisis were: (1) the lack of fixed-price forward contract coverage of the retail load obligations of the three large load-serving entities in California and (2) the lack any final demand that was responsive to the hourly wholesale electricity price. These two factors created circumstances that were extremely conducive to suppliers in the

California electricity market raising wholesale electricity prices through their unilateral actions, which occurred starting in June 2000.

A final demand that was not responsive to the hourly wholesale price meant that all suppliers knew that regardless of the level of the hourly wholesale price, system demand during a given hour of the day would not change. This is different from other markets where suppliers know that, keeping all other factors constant, a higher price lead to a lower market demand. Competition among a few suppliers to serve a demand that is invariant to the hourly wholesale price results in substantially less competitive market outcomes relative to the case where the market demand falls in response to higher hourly prices.

The lack of fixed-price forward contract coverage of the wholesale demand of the large retailers in California meant that supplies were received the short-term price for virtually all of the output they produced. This gave all suppliers a strong incentive to raise the hourly short-term price. In contrast, a supplier that has sold a significant fraction of its expected output in a fixed-price forward contract will only earn the short-term market price for what it sells beyond this forward contract quantity and this can significantly the incentive the supplier has to raise short-term wholesale prices.

A high level of forward contract coverage of the expected output of each supplier also creates the following virtuous cycle in market participant behavior. If each supplier knows that other suppliers have significant fixed-price forward contract obligations to meet, then the supplier also knows that it will have to submit low offer prices (relative to its variable cost) into the short-term market to be assured of covering its forward contract quantity with sales in the short-term market. Aggregating these offer curve submission across all suppliers produces short-term market outcomes close to competitive benchmark levels.

Unfortunately for the citizens of California, the low levels of fixed-price forward contract coverage of final demand in California led to an "unvirtuous" cycle of supplier behavior starting in June 2000. Each supplier knew that it did not have to submit offer prices close to its variable cost because of the reduced amount hydroelectric energy available in the Pacific Northwest to sell into California during the Summer of 2000. Because each supplier also knew that all other suppliers had virtually no fixed-price forward contract obligations that cleared against short-term prices in California, each knew there would be no suppliers submitting offers close to their variable costs because of the desire to cover their forward contract obligations with short-term market sales. In this way, all suppliers had a common interest in higher short-term prices because of their limited forward market obligations.

The California Electricity Crisis was fixed by correcting the initial defect—the low levels of fixed-price forward contract coverage of final demand in California. Although former Governor Gray Davis may have lost his job for signing these contracts, as discussed in my paper "Diagnosing the California Electricity Crisis" once the long-term contracts entered into by the State of California during the winter and spring of 2001 began making deliveries during the summer of 2001, the performance of the short-term market in California improved dramatically. These contracts have continued to limit the incentives for suppliers to the California to raise prices in the short-term wholesale market. Moreover, since the end of the crisis, the California Public Utilities Commission has implemented an annual Resource Adequacy (RA) process to ensure that three large load-serving entities in California—Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric—have adequate levels of fixed-price forward contract coverage of their annual wholesale electricity demand.

California's policy of maintaining high levels of fixed-price forward contract coverage of

final demand has produced wholesale market outcomes in the state that rival the best performing wholesale markets in other parts of the United States. In addition, in April of 2009 the California ISO implemented a locational marginal pricing or (LMP) market that has reduced the cost of operating of fossil fuel generation units in the California ISO control area.[1] The LMP market design is ideally suited to facilitate the least cost deployment and operation of intermittent renewable resources and to provide hourly temporal and spatial price signals for the developing active participation of final demand in the wholesale market.[2]

3. California's Energy Regulatory Challenges

California has the goal of an affordable, reliable and renewable supply of the electricity. To this end, the state has set the extremely ambitious, but very laudable, goal of having 33% percent of its electricity consumption come from designated renewable resources by 2020. Achieving these renewable energy goals with minimal retail price increases and maintaining historical levels of grid reliability presents a number of challenges for the existing energy regulatory structure in California.

The first challenge is the substantial increase in the variability in the real-time supply of electricity with a larger share of renewable energy on the system. The experience of Spain, which has one of the world's largest wind energy share is instructive. There are days when the electricity grid in Spain goes from an over-generation condition because there is more wind energy than demand, to a situation where there is close to zero wind energy and all of the fossil fuel units on the system must operate. Besides significantly increasing the demand for operating reserves

[1] Wolak, Frank A. (2011) "Measuring the Benefits of Greater Spatial Granularity in Short-Term Pricing in Wholesale Electricity Markets," American Economic Review, May, pp. 247-252, find average hourly dispatch cost and total energy consumption reductions for the same total fossil fuel output level under the post-April 1, 2009 market design relative to the former market design.

[2] Wolak, Frank A. (2011) "Quantifying the Benefits of Spatial versus Temporal Granularity in Retail Electricity Pricing," available from http://www.stanford.edu/~wolak, documents the increased benefits to spatial and temporal pricing of wholesale electricity to load using data from California's LMP market.

and flexible demand, this increased intermittency will also increase the amount of volatility in real-time wholesale electricity prices.

This increased price volatility, if passed on in the hourly retail price paid by final consumers with interval meters, can create the business case for investments in storage technologies and active participation of final demand in the wholesale market. California is ideally suited for active participation of final demand in the wholesale market because all customers of the three major load-serving entities in California will soon have interval meters than can record their consumption on at least an hourly basis. This makes it possible to charge all consumers retail prices that vary with real-time system conditions, what is often referred to as dynamic pricing.

Customers with interval meters that face dynamic prices are functionally equivalent to a generation unit in the sense that they are able to provide demand reductions, what are often called, "negawatts", in response to increases in the hourly wholesale price. There is ample empirical evidence from a variety of dynamic pricing experiments, many of which I have been directly involved in, that customers facing prices that vary with real-time system conditions reduce their hourly consumption by a substantial amount in response to hourly price signals.[3]

Results from a recent experiment in Washington DC that I participated in, found between 15 percent and 20 percent demand reductions by residential consumers during hours with high retail prices.[4] These results suggest the widespread adoption of dynamic pricing can provide system operators with substantial demand-side resource to manage the real-time demand and supply balance.

Another important challenge for California's energy regulatory policy is a regional transmission planning process that allows California access to the least cost sources of renewable

[3] Wolak, Frank (2006) "Customer Response to Real-Time Pricing: The Anaheim Critical-Peak Pricing Experiment," describes the results of dynamic pricing experiment in the Anaheim Public Utility service area where significant demand reductions (greater than 10 percent) were estimated to occur during critical peak pricing periods of the day.
[4] Wolak, Frank A. (2010) "An Experimental Comparison of Critical Peak and Hourly Pricing: The PowerCentsDC Program," available at http://www.stanford.edu/~wolak.

energy. California is part of the entire Western Electricity Coordinating Council (WECC) which is composed of all of the Western States and two western provinces in Canada. Figure 1 contains a map of the WECC. Energy injected anywhere within the WECC can be used to serve load in any location in the WECC if there is sufficient transmission capacity to allow the energy to be injected.

Figure 2 gives the geographic location of wind resources in the entire United States. As this figure makes clear, there are extremely rich wind resources in the WECC, but very few are in California. There are wind resource areas in Wyoming that are capable of producing wind energy with an annual capacity factor of 45 percent. The capacity factor of generation unit is the ratio of the total output a unit actually produces divided by the hypothetical output it could produce if it ran at full output all hours of the year. A good wind resource in California has capacity factor of roughly 25 percent. It is also cheaper to site and construct wind facilities in Wyoming and Montana relative to California. There are a number of independent studies that estimate the an average cost of wind energy produced in Wyoming and Montana that is less than half the average cost of wind energy produced in California.

There are currently a number of regulatory barriers to California consumers accessing these inexpensive wind energy resources. The first is the lack of transmission to access these rich renewable resource areas that allows the wind energy to be injected into the WECC transmission grid. The second is the current regulatory barriers to counting renewable energy produced outside of the state towards meeting California RPS goals, in spite of the fact that wind produced in areas like Montana or Wyoming is likely to displace more greenhouse gas emissions than wind energy produced in California because of the prevalence of coal-fired power plants in these regions.

A focus on California-only renewable resources to meet the state's RPS goals, is contrary to the approach California has traditionally taken to meeting it electricity needs. Because of the presence of inexpensive hydroelectric resources in the Pacific Northwest and inexpensive coal-fired electricity in the Desert Southwest, California has historically relied on imports to meet

roughly one-quarter of its energy needs. These inexpensive imports of electricity have helped fuel California's economic growth over the past 40 years. Similar logic can be applied to the case of renewable energy. However, without a regional transmission planning process that causes the necessary transmission to be built and paid for to interconnect these renewable resources, it will be extremely difficult for California to access these inexpensive renewable resources outside of the state.

4. Recommended Regulatory Changes to Meet California's Energy Goals

In the past 15 years, the introduction of formal wholesale electricity markets and the desire scale the share of renewable energy mix has significantly changed the regulatory needs of the electricity sector in California. The active participation of final demand in the wholesale market is essential to managing the greater intermittency of renewable resources and in limiting the ability of wholesale electricity suppliers to exercise unilateral market power. A demand that is able to reduce its consumption in real-time in response to higher prices limits the ability of suppliers to exercise unilateral market power in a formal wholesale market such as the California ISO.

The desire to scale significantly the share consumption in California served with renewable energy coupled with the fact that many rich sources of renewable energy are not within California's borders implies the need for a WECC-wide transmission planning and procurement process. This statement is particularly relevant, if California is going to meet its renewable energy targets and still achieve the goals of an affordable and reliable supply of electricity. To give an idea of the scale of the challenge in meeting that state's 33% RPS goal by 2020, consider the fact that between 2003 until 2011, California installed slightly more than 2000 MW in RPS-qualifying generation capacity. A recent CPUC report estimates that between 2011 and 2020, an nine-year instead of eight-year time interval, between 8 to 10 times that amount of renewable generation capacity will need to be installed to meet the 33% RPS goal, depending the

electricity demand growth over the next nine years.[5] Taking a California-only approach to this challenge is likely to considerably increase the cost to California consumers to meeting the state's RPS goals.

Under a wholesale market regime, the transmission network takes on the additional role as a facilitator of commerce, by expanding the size of the market over which any given supplier faces competition. By facing suppliers with greater competition during all hours of the year, they will forced to submit price offers closer to their variable costs of production which will yield market prices closer to competitive benchmark levels. A regional approach to transmission planning led by California will also benefit California consumers by giving them access to inexpensive renewable resources throughout the WECC, rather than simply those in California.

My major regulatory policy recommendations are:

1) Introduce symmetric treatment of load and generation for all customers with interval meters. This simply means that default price that these customers pay is the real-time price for electricity. They are free to purchase a hedge against this real-time price risk, but in order to escape this exposure they much purchase such a hedge.[6]
2) Direct access or retail competition with a default pass-through of real-time prices is the most straightforward way to introduce symmetric treatment. However, any introduction of retail competition should be accompanied by a state-level regulatory oversight of electricity retailers to ensure that they do not take excessive risks at the expense of electricity consumers. The CPUC must monitor these entities to ensure that any

[5] California Public Utilities Commission (2011) "Renewables Portfolio Standard Quarterly Report, 1st Quarter 2011.
[6] Wolak, Frank A. (2009) "Managing Demand-Side Economic and Political Constraints on Electricity Industry Re-structuring Processes," available from http://www.stanford.edu/~wolak, discusses the concept of symmetric treatment of load and generation and how this can be implemented in manner that maximizes the benefits that electricity consumers realize. Bushnell, James, Hobbs, Benjamin, and Wolak, Frank (2009) "When It Comes to Demand Response, Is FERC Its Own Worst Enemy?" The Electricity Journal, Vol. 22, Issue 8, 9-18, discusses the inefficiencies introduced by tradition approaches to demand response applied to the formal wholesale market context.

fixed-price products that they sell to final consumers are hedged against wholesale market price risk.

3) Focus California's planning process on transmission throughout the entire WECC to achieve the goals of a affordable, reliable and renewable supply of energy for California. Policies that focus only on California sources of renewable energy are likely to be significantly more expensive and less reliable because they do not take advantage of lower levels of correlation between wind and solar patterns in the rest of WECC and California.

4) Build transmission infrastructure to lead generation investments. There is a formal wholesale electricity market in California where suppliers are free to enter where and when they believe it will be profitable to enter. A forward-looking transmission planning process that anticipates these profit-maximizing entry decisions can limit the cost transmission expansions, yet stimulate robust competition to supply wholesale energy to California that should benefit all California consumers.[7]

California has the physical infrastructure to be a leader in dynamic pricing and renewable energy consumption. Policies that embrace the production of renewable energy regardless of where the resource is located in the WECC and sets retail prices for electricity for consumers with interval meters that reflects the real-time cost of supplying that energy at each location in the state will spur innovations and investments in storage and demand flexibility technologies in California that can later be sold throughout the United States and world as more countries increase their share of renewable energy consumption.

[7] Wolak, Frank A. (2010) "Reducing the Regulatory Barriers to a Low Carbon Energy Future," available at http://www.stanford.edu/~wolak, discusses the benefits of a forward looking transmission policy. Wolak, Frank A. (2003) 'The Benefits of an Electron Superhighway," available at http://www.stanford.edu/~wolak, describes the competition benefits of transmission expansions.

Figure 1: Map of Western Electricity Coordinating Council (WECC)

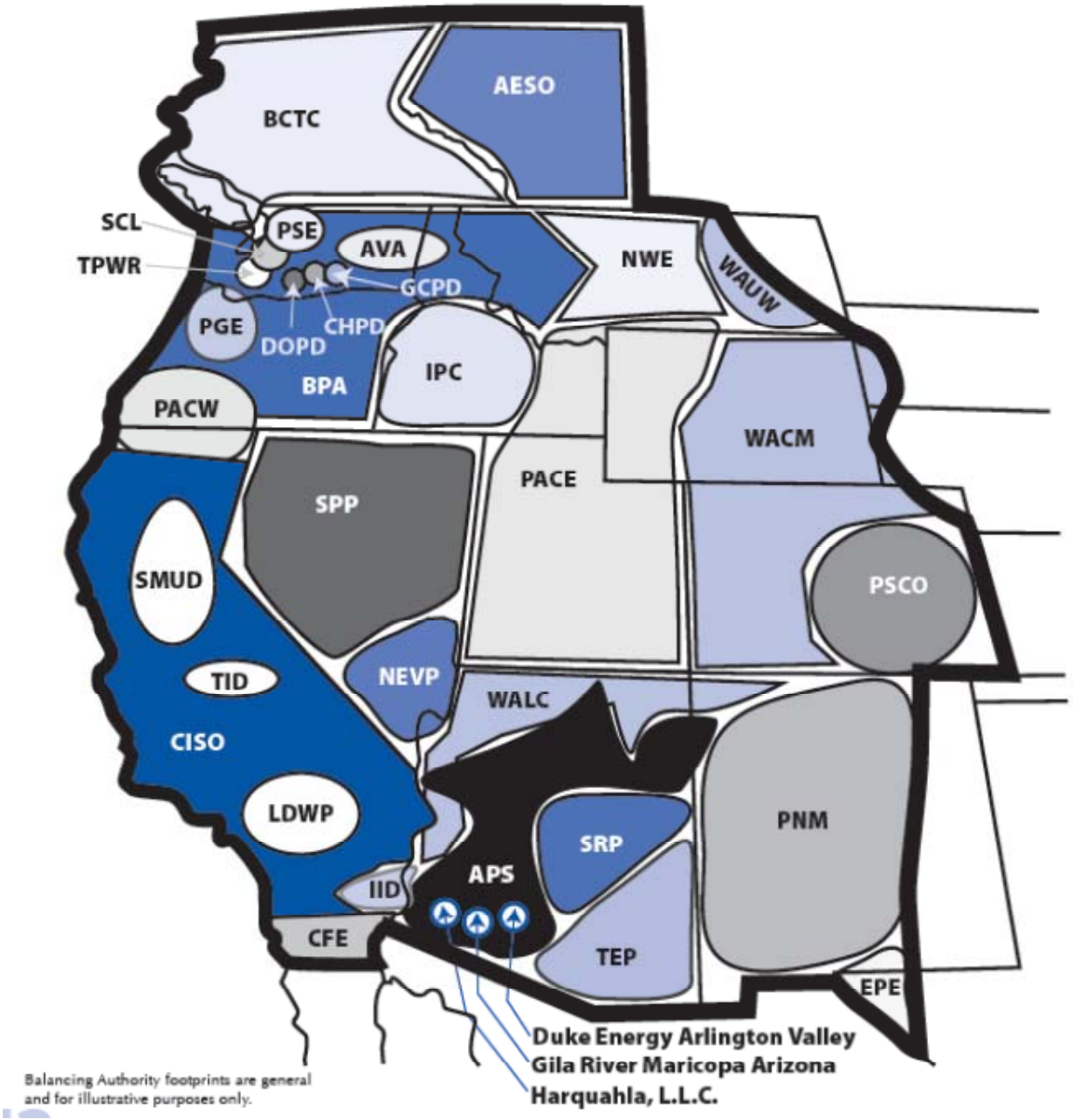

Figure 2: Spatial Distribution of Wind Resources in the United States