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Wind Power In California's Restructured Electric Market: Wind and the California ISO

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EXECUTIVE SUMMARY

The California Independent System Operator (CAISO) began operating in March 1998. It is an independent, non-profit entity established under California's restructuring legislation to ensure the reliable and safe operation of California's regional electricity transmission system. Its functions include scheduling bulk power transmission, accounting for transmission losses, planning transmission system improvements, and operating markets for ancillary services, real-time imbalances, and congestion management. Each of these functions affects the extent to which wind and other traditional and non-traditional generating resources participate fully in California's energy supply markets.

This case study explores the experience of new and existing wind energy generating resources under California's electric industry restructuring efforts, examines CAISO's role in wind energy's experience in California, and draws conclusions that may be applied to other regions seeking to develop regional transmission organizations (RTOs) under FERC Order 2000.

The case study makes the following key conclusions:

- ? *Wind and other intermittent resources require fair and open access to energy markets, but RTO policies may not be the primary driver of wind resource development in a region.* For the most part, CAISO's attempts to facilitate the development of competitive energy markets have neither encouraged nor discouraged development of wind generating facilities in California. Instead, wind development in California under restructuring has been driven primarily by the existence of state and federal incentives for producing and purchasing energy derived from wind and other renewable resources.
- ? *The adoption and implementation by RTOs of market-based policies may not be sufficient to guarantee efficient market outcomes.* In California, structural factors such as a limited number of market participants and a lack of sufficient reserve capacity have prompted recent and well-publicized market problems as well as numerous market redesign efforts. These structural factors have had a disproportionate impact on small and intermittent generation resources such as wind, which rely more heavily on well-functioning short-term and ancillary services markets in which to sell generated energy and purchase backup energy.
- ? *RTOs may be limited in their ability to mitigate or resolve problems associated with wind's intermittency.* Intermittency decreases the value of wind energy relative to energy derived from more stable generation resources in competitive markets. Even in ideally designed competitive markets, wind is forced by its intermittency to sell into shorter-term, real-time, and/or uninstructed energy markets, where demand and price stability is more uncertain than in longer-term forward markets. This restriction decreases the value of the wind energy commodity and may offset a portion of the benefits wind may derive from the sale of green energy credits. In California, no new wind generator to date sells power directly into the state's long- or short-term competitive markets; instead, California's new wind generators have pursued bilateral contracts with power marketers or retail energy providers for their energy, passing on all or a portion of the risks of intermittency to another entity.
- ? *Wind interests may benefit by forming alliances with load management interests in encouraging RTO policies that accommodate such resources.* Most existing ISOs and new RTOs proposed in response to FERC Order 2000 have not yet effectively accommodated load management services in their long- or short-term markets. Adoption of policies that encourage RTOs to view intermittent generating resources in a similar manner as loads could benefit intermittent resources such as wind. There is inherent logic to the idea that wind and other intermittent resources appear to RTOs as variable and largely uncontrollable, much like loads; in fact, wind is often modeled by utilities as a negative load. If CAISO or other RTOs attempt in the future to accommodate load management services alongside generation resources, such accommodation may provide improved opportunities for wind and other intermittent resources to compete against traditional generation resources.

? *Unique characteristics present in California complicate the application of lessons learned by CAISO and California's wind generators to other regions forming RTOs.* To begin with, California is now in the third year of a four-year transition to competition period scheduled to end in 2002. During the transition period, California's market transactions are affected by a variety of financial charges and credits; it therefore may be too early to tell how wind will fare in the state once full competition takes effect. Another unique characteristic in California is the state's enormous base of existing wind capacity operating outside of competitive markets under long-term contracts, most of which is based on older, less-efficient technology that may not be able to compete under competition. While installations of new wind generators in other regions will likely result in a net increase in wind generating capacity, California may experience a net decrease in wind capacity as these older units come off line at a faster rate than new units come online. Market characteristics in every RTO are different, and RTO policies must be designed to meet these unique circumstances.

As the first state to offer retail customer choice and competitive generation and ancillary services markets, California deserves credit for early experimentation in restructuring. CAISO has played a key role in facilitating both reliability and efficient markets, and its ongoing market redesign efforts in response to perceived market flaws can be instructive. It will be important for wind generators to understand how the California markets work and to apply lessons learned in California to other regions in the process of developing RTOs.

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1. INTRODUCTION

The state of California opened its doors to retail competition for electricity in April 1998, becoming one of the first states, and certainly the largest, to undertake such an experiment. The move toward competition spurred both excitement and concern among renewable energy advocates, including the wind energy community: excitement for the new opportunity to sell “green” energy into one of the largest, and what many considered to be one of the most environmentally conscious, markets in the nation; concern that competitive markets might not highly value wind and other intermittent, small scale, and non-traditional energy generation technologies.

Today, over two years after California began implementing its restructuring plan, we can begin to see the effects of this restructuring effort on the market for generation, including wind generation. In implementing an incentive program funded by California’s system benefits charge, the state made commitments in 1998 to support development of approximately 300 MW of new wind capacity over the next four years, yet to date only about 18 MW of this commitment has come online. About 200 MW of the remaining capacity is scheduled to become operational over the next two years, and it is uncertain whether the remaining capacity will be installed at all.

What factors have driven the wind energy situation in California over the past two years, and to what extent has this situation been influenced by the operation of the California Independent System Operator (CAISO)? As other states move toward restructuring their electric utility industries, and as electric utilities themselves move toward participation in regional transmission organizations (RTOs) as required by FERC Order 2000, what lessons can be learned from CAISO’s experience?

This case study attempts to answer these questions by describing the current policies and day-to-day operation of CAISO as they relate to planning, operating, and scheduling wind power and other intermittent generating resources, and by highlighting the effects these policies have had on wind development in California. The study also describes proposed changes to CAISO as it moves further in the direction of an RTO in response to Order 2000, with special emphasis given to proposed changes that will most affect wind. Finally, the study communicates lessons learned on wind-related transmission issues that may be relevant to other RTO developments around the country.

The information in this study should be useful to those interested in the operation of wind resources in California, in the operation of CAISO itself, and in the changes that are being made to move CAISO further in the direction of an RTO fully consistent with Order 2000. Those involved in the formation of other RTOs will also find the study useful.

2. HISTORY OF CAISO DEVELOPMENT

The California legislature passed the state’s electric industry restructuring bill, AB 1890, in 1996. Prior to its enactment, generation, transmission, and distribution functions were handled by the state’s three major vertically-integrated investor-owned utilities (IOUs): Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E).

AB 1890 established CAISO as a not-for-profit public benefit corporation regulated by the Federal Energy Regulation Commission (FERC), charged with serving as the control center for the state’s bulk electricity transmission system and ensuring that energy reaches its destination safely and reliably. CAISO combines the scheduling functions performed by the control areas previously operated by PG&E, SCE, and SDG&E. Together, these three IOUs retain ownership of most of the transmission facilities under CAISO’s control. CAISO now controls approximately 75 percent of California’s power grid, and approximately 82 percent of the state’s aggregate electricity load passes through the CAISO. More than 600 power plants, with a combined generating capacity of 45,000 Megawatts (MW), are connected to the CAISO grid.¹

¹ <http://www.caiso.com/aboutus/infokit/PowerGrid.html>

AB 1890 required the IOUs to relinquish control, but not ownership, of their long distance electricity transmission lines to CAISO. Upon doing so, the IOUs' distribution arms continue to provide regulated distribution service but no longer control their transmission systems or contract for power supplies directly with their affiliated generators. The legislation also created a separate power market, called the California Power Exchange (CalPX), into which the IOU's generation assets are required to sell all of their generated power and from which their retail arms are required to, and other retail energy providers may, purchase their power needs. Both the CAISO and the CalPX became operational in April 1998. IOUs are required to sell their power into the CalPX for the duration of a four-year transition period that ends March 31, 2002.

Comment: Too much detail; I would just say both the PX and ISO began operations in April 1998.

CAISO is governed by a Board of Directors containing no more than 31 members that represent the following classes of stakeholders: IOU transmission owners, municipal utilities, governmental market participant entities, non-utility electricity generators, public buyers and sellers, private buyers and sellers, agricultural end users, industrial end-users, residential end-users, end-users at large, public interest groups, and non-market participants.² The current CAISO Board of Directors is comprised of 27 members.

3. CAISO FUNCTIONS

CAISO's major operational functions include scheduling transmission and operating open markets for congestion management, ancillary services, and real-time imbalances. CAISO also establishes transmission pricing tariffs and develops approaches to managing congestion and calculating and accounting for transmission losses.

Transmission Scheduling

Generators communicate with the CAISO through a scheduling coordinator to gain access to the open market power grid CAISO operates. CAISO establishes protocols to certify parties, including the CalPX and Automated Power Exchange (APX, a privately-owned alternative to the CalPX), as scheduling coordinators. Each participant using the grid is required to designate a scheduling coordinator who is responsible for submitting balanced schedules to CAISO for all buyers and sellers. By law, the CalPX acts as the scheduling coordinator for the IOUs, but any customer, retail or wholesale, that meets certain technical and credit criteria may serve as its own scheduling coordinator. Upon receipt of the proposed schedules, CAISO is charged with modeling the proposed transmission and identifying potential congestion. If CAISO determines that no congestion is likely, it approves and posts the schedules as submitted. If CAISO determines that congestion is likely along certain paths, it initiates a series of actions that allow market participants a chance to resolve congestion issues on their own before CAISO implements its own solutions. The congestion management process is described in more detail below.

Energy Market Operations

CAISO operates markets for congestion management, ancillary services, and real-time imbalances. Due to the intermittent nature of wind, wind generators face unique challenges in selling services into these markets, but frequently act as buyers, especially in ancillary services and real-time imbalance markets, of services that firm up predicted generation. For this reason, wind generators have a special interest in ensuring that these markets function efficiently. CAISO also recently redesigned its real-time imbalance market to settle imbalances on a 10-minute basis. This new 10-minute market became operational in September 2000. Due to its unique characteristics, many wind generators view the new 10-minute market as a promising outlet in which to sell wind energy, despite persistent challenges associated with intermittency that limit the ability of wind resources to capture sustainable prices for their energy.

Congestion Management Market

After scheduling coordinators have submitted their proposed day-ahead hourly generation and load requirement schedules, CAISO studies the statewide impact of the proposed operation on the transmission system. In the event that CAISO determines there is likely to be congestion along certain paths, CAISO

² 2000 United States Regional Transmission Organization Study, EFI (Boston, Massachusetts), 2000.

operates a congestion management market that works by accepting adjustment bids from schedulers on a day-ahead and hour-ahead basis. If this market doesn't generate voluntary, market-based solutions to the congestion problems, a congestion management charge is levied on scheduling coordinators that continue to schedule power over lines that are in heavy use. The charge is based on the difference between the cost of the modifications versus the unconstrained market clearing prices. CAISO uses the fees collected through the congestion management charge to pay generators to modify their operation to relieve the congestion. In doing so, CAISO employs algorithms to determine which proposed solutions would cause the least impact on schedules at the least cost.

CAISO uses a zonal approach to congestion management. The state is divided into three zones – a northern zone (NP15), a southern zone (SP15), and a flexible central zone (ZP26) – and energy flows are modeled along rated paths between these zones. (The zones are shown in the network model presented in Appendix A.) CAISO initially chose a zonal approach to simplify the system by reducing the number of markets that transmission participants would need to monitor. One consequence of using the zonal approach is that it blurs the effects of transactions that occur within a zone; that is, while the approach can be used to expose and manage inter-zonal congestion reliably through the congestion management market, intra-zonal congestion must be managed through other means. FERC has proposed that CAISO move away from its zonal approach and toward a locational marginal pricing approach, in which real-time market prices for relieving congestion would be revealed at every major transmission system junction in the state. CAISO currently is moving toward a compromise solution that would increase the number of zones from the current three to seven or eight.

Ancillary Services Market

CAISO runs four ancillary services markets including separate hour-ahead and day-ahead markets for regulation (or load following), spinning reserves, non-spinning reserves, and replacement reserves. Since the intermittent nature of wind makes it difficult for wind generators to respond to CAISO instructions, they do not qualify to sell into existing ancillary services markets. However, wind generators frequently require access to ancillary services markets to which they can turn for services that firm their generation.

California's ancillary services markets have not developed enough to encourage a substantial number of generators to modify their operation to bid into them. This is one reason why prices for reserves in California have spiked to extraordinary levels on hot summer days in 1998 and 2000. These price spikes have caused structural as well as political problems within CAISO. In response, CAISO, with approval from FERC, has instituted price caps in reserve markets to mitigate these problems. Replacement reserves were capped at \$750/MWh at the beginning of summer 2000, but the CAISO Board has since lowered the cap even further in response to consumer, utility, and political complaints about high prices.

Interestingly, while the price caps instituted by CAISO do offer consumers some relief from high prices for peaking power, they have had unintended consequences that exacerbate the problem of undersupply. Many have argued that price caps in the ancillary services markets give scheduling coordinators an incentive to underschedule their resources at the CalPX and other exchanges, where price caps are higher or non-existent. They argue that schedulers would prefer to underschedule and pay CAISO to make up the difference and bill them for it at capped rates, rather than schedule more accurately at the CalPX or another exchange and risk having to pay the higher, market rate for peaking resources. A consequence of alleged underscheduling has been to place the burden for procuring a high percentage of the state's power needs on CAISO's imbalance markets rather than on the market-based scheduling processes where they were intended to be addressed.³

Price caps also have provided incentives for in-state generators to sell peaking resources in out-of-state markets where they can command higher prices, and have required CAISO to search, sometimes in out-of-state markets, for peaking resources needed within California.

³ CAISO's imbalance market was designed primarily to accomplish load following and emergency procurement, which typically utilize only 1-2 percent of the total power generated at any time. On certain days CAISO has needed to procure in imbalance markets 10-15 percent of the total power generated.

Real-Time Imbalance Market

Another CAISO function is to match the instantaneous load with the instantaneous generation statewide. CAISO operates a real-time imbalance market that is open to both in-state and out-of-state participants. The generation of imbalance service providers can be adjusted on a second-by-second basis by CAISO dispatches. This real-time balancing market is of great interest to wind interests who must account for the intermittent nature of their generation.

New 10-Minute Settlement Period

Under the recent imbalance energy market rules in California, different resources were dispatched over different intervals, but the settlement of market obligations was not always tied to the dispatch period. Specifically, while the settlement period for instructed imbalance energy was ten minutes, uninstructed deviations from hourly schedules were settled at the hourly ex post price.⁴ CAISO believed that this discrepancy caused inefficient and unintended operational consequences.⁵ To address this problem, CAISO developed, and FERC approved,⁶ tariff revisions that settle uninstructed deviations on a 10-minute basis. The revised market structure began operating on September 1, 2000. The new settlement period operates in 10-minute blocks, and the market for each hour closes 40 minutes before the top of the scheduled hour.

In the 10-minute market, scheduling coordinators that provide incremental or decremental energy in accordance with CAISO instructions in a 10-minute interval are paid the interval-clearing price for the energy, and CAISO's cost of this energy is allocated to generators with uninstructed deviations. According to CAISO, "this means a resource owner that chooses to deviate in real time will maximize profit over the long term by submitting bids and being instructed, rather than by engaging in uninstructed deviations."⁷

While this new market structure may further CAISO's goal of operating more efficient markets for real-time imbalances, it may harm wind and other intermittent generating resources that previously depended on market rules allowing uninstructed energy to be valued at instructed energy rates.

At the same time, however, the existence of 10-minute settlement periods may provide wind generators with an opportunity to submit more reliable short-term bids for instructed positive real-time imbalance energy. Wind generators who were fairly certain on an hour-ahead basis that their facility would produce energy in excess of previously made obligations could submit bids to supply the excess energy in accordance with CAISO instructions in the real-time market. Wind generators may actually have an advantage over fossil fuel generators, and particularly gas generators, in their ability to provide incremental energy. Gas generators experience thermal stress on their units caused by ramping power production upward or downward over short time intervals; since wind turbines operate by converting mechanical rather than thermal energy into electricity, wind generators have no such constraints.

Still, since wind generators must operate in response to an intermittent resource, it is more difficult for them to submit accurate bids and act on instructions, even over short lead times, than it is for more traditional fossil fuel generators. Also, the imbalance energy market relies on an automated dispatch system

⁴ Resources supplying imbalance energy are dispatched by the CAISO's Balancing Energy and Ex Post Price (BEEP) software. The hourly ex post price is the "weighted average of the prices paid or charged to resources that are instructed during the hour's six ten-minute dispatch intervals."

⁵ These consequences include: 1) inefficient price signals that result in the CAISO's inability to rely on imbalance energy for load following, 2) decreased incentives for scheduling coordinators to submit bids into the imbalance energy market, 3) prices for incremental energy imports remaining "stuck" at the hourly price, even though less costly resources could meet the ISO's needs, and 4) poor response to CAISO's dispatch instructions. Order Conditionally Accepting Proposed Tariff Revisions, Docket No. ER00-2383-000, Federal Energy Regulatory Commission, Issued June 29, 2000.

⁶ Order Conditionally Accepting Proposed Tariff Revisions, Docket No. ER00-2383-000, Federal Energy Regulatory Commission, Issued June 29, 2000.

⁷ California ISO's 10-Minute Settlement Proposal: Background and Economics, Attachment to Memorandum to ISO Board of Governors re. Market Redesign – 10-Minute Markets, dated March 14, 2000. Available at <http://www.caiso.com/docs/2000/05/03/2000050308310121787.pdf>.

that normally is not used with intermittent resources such as wind. The task of integrating wind resources into this system in a manner that guarantees timely and reliable response could prove to be a major obstacle to wind's participation in these markets. Further, the shift toward 10-minute settlement periods may move prices for instructed energy in the direction of efficient market prices which, if CAISO's reasoning for implementing the new settlement period is correct, ought to be lower than the prices experienced in California recently. This, too, will not benefit wind generators.

Uninstructed energy in the new real-time market is priced based on the marginal cost that CAISO incurs to accommodate the uninstructed deviation. That is, to accommodate an uninstructed decremental deviation, CAISO must increment resources that have submitted incremental energy bids and pay them the interval-clearing price for incremental energy. CAISO therefore charges this incremental energy price to the scheduling coordinator responsible for the uninstructed decremental deviation. Similarly, for uninstructed incremental deviations, CAISO pays scheduling coordinators a price equal to the interval-clearing price for decremental energy.⁸ CAISO explains that as long as generators supplying energy on an uninstructed basis do not receive more for their energy than it is worth at the time it is supplied, they should not be discouraged from responding to the price signal. This pricing mechanism presents an opportunity for wind generators to simply sell their energy as uninstructed incremental deviations and take the prevailing interval-clearing prices for instructed decremental energy.

Transmission Pricing

California effectively has a postage stamp rate for transmission access statewide. This means there is no distance-based charge to use the transmission system. These charges are all paid by load in a per kWh charge that covers the cost of the existing transmission system. This is the preferred method of cost recovery by most wind interests (and other generators) since it ensures that transmission access charges are blind to the specific form of generation. Neighboring RTOs in the west, including RTO West in the Northwest and Desert Star in the Southwest also plan to allocate their fixed costs to load.

Accounting for Transmission Losses

CAISO calculates transmission losses using General Meter Multipliers (GMMs). First, CAISO forecasts and publishes total control area demand. This is done before scheduling coordinators are required to submit their balanced, day-ahead schedules. After CAISO receives the day-ahead schedules, it models the proposed generation against forecast demand to estimate transmission losses throughout the system; CAISO then publishes GMMs for each settlement period. After determination of final generation and demand schedules in the hour-ahead market, CAISO uses a power flow model to determine revised GMMs. CAISO considers differences between scheduled and revised transmission losses to be an imbalance energy deviation, and these differences are purchased or sold in the real time market.

Transmission Planning

Future changes and additions to the CAISO grid are planned through the ISO Grid Coordinated Planning Process. The planning process is designed to be flexible, allowing projects to be generated from a variety of sources including transmission owners, CAISO, or any entity who participates in the energy marketplace through the buying, selling, transmission or distribution of energy or ancillary services into, out of, or through the CAISO grid.

The planning process begins when CAISO or other market participants identify proposed transmission projects or transmission needs. For participating transmission owners (PTOs), this identification is made in their annual transmission plans, which are required by CAISO and subject to CAISO review and approval. A separate process is specified for facilitating interconnection to the CAISO grid. This interconnection process is primarily between the applicant and the PTO.

⁸ Positive bids for supplying decremental energy signify that generators are willing to pay CAISO to decrement generation that is more expensive than that which can be purchased through the imbalance market or made up through other generation assets. CAISO therefore passes on the revenues from accepted decremental energy bids to suppliers of uninstructed incremental deviations to make up the difference.

After a proposed project is identified and meets CAISO approval, and if the project is deemed to have regional impacts, it may be subject to review in the Western Interconnection Coordinated Transmission Planning Process (WICTPP). Through this process, the proposed project undergoes analysis of its impact on the regional transmission system and path ratings. To the extent possible, the CAISO planning process utilizes the WICTPP to streamline the planning process and avoid redundancy.

All proposed projects also need to go through a CAISO review process. The review process is focused on ensuring that projects connected to the CAISO grid meet CAISO grid planning criteria. For many projects, the assessment of whether they meet the grid planning criteria will already have been made as part of the WICTPP. In addition, concurrently with the WICTPP, CAISO will conduct an operational review to ensure that the project meets CAISO's needs for operational flexibility and requirements for integration with the CAISO grid. Many projects will also need to be evaluated from an economic perspective to determine whether the costs should be incorporated into the access fee or split among beneficiaries.

Finally, at the end of the process, the project is permitted, designed, and constructed. CAISO tracks construction to ensure the project is in service when needed.⁹

4. REGULATORY AND MARKET CONTEXT

CAISO operates in a regulatory and market context that is unique to California. The additional entities that primarily affect CAISO and wind facilities include two competitive power exchanges, which conduct auctions of electric power supplies and facilitate setting prices.¹⁰

California Power Exchange (CalPX)

The California Power Exchange (CalPX) was established under AB 1890 to act as the primary wholesale exchange for power in the California market. Unlike CAISO, the CalPX operates in a competitive environment and is not the only power exchange now operating in California. Its major competitor is the Automated Power Exchange (APX), a private company that operates an alternative exchange as well as a separate green power exchange. While the CalPX enjoys the largest share of bulk power transactions in California, after the transition period ends all generators, including IOU-affiliated generators, will be able to choose among available exchanges.

The purpose of the CalPX is to auction electric power supply and facilitate the matching of supply with demand. The state's distribution companies are required to purchase all their load requirements, and the IOUs are required to sell any power from generation they own or that is under contract with them, through the CalPX. The vast majority of the power sold through this exchange is derived from nuclear, fossil, and large hydroelectric facilities.

CalPX Markets

CalPX operates two markets where energy is traded on an hourly basis as well as a block forward market for energy trading up to six months in advance.

- ? The Day-Ahead market establishes prices and quantity of electricity for delivery during each hour of the following day. At 7 a.m. each day, the CalPX conducts 24 separate hourly auctions. CalPX makes the results of these auctions, in the form of hourly "unconstrained market clearing prices," publicly available by 9 a.m. each day. In the event that CAISO determines that congestion is likely, CalPX makes public zonal pricing information for day-ahead delivery at 3 p.m.

⁹ ISO Grid Coordinated Planning Process, Revision 6. January 23, 1998. Available at <http://www.caiso.com/thegrid/planning/gridplanningprocess/index.html> (downloaded September 1, 2000).

¹⁰ The California Energy Commission's Renewable Energy Program, which provides incentives for renewable energy generators as well as for consumers who choose to purchase power from renewable resources, and green power certification programs operated by the California Energy Commission and Green-e, also affect the market for wind energy in California. These programs are summarized in Appendices B and C.

- ? The Day-Of-Hour-Ahead market operates similarly, but offers trading closer to the delivery hour. This market originally began as an hour-ahead market that was operated 24 times a day, but was reconfigured to a day-of market in order to reduce the number of auction periods and increase efficiency. It conducts 24 hourly auctions during three auction periods at 6 a.m., noon, and 4 p.m. Auction prices for each hour become publicly available throughout the day.
- ? The Block Forwards market offers standardized contracts for on-peak energy on a forward month basis. Each contract is based on a specific future month at a certain quantity for the 16-hour peak period from 6 a.m. to 10 p.m., excluding Saturdays and Sundays.

Wind resources could potentially sell energy directly into each of these markets, but due to the difficulty of predicting wind generation on a forward basis, no wind facility in California currently does so.¹¹

Green Exchange Service

Since April 1999, the CalPX has offered a Green Exchange Service to assist renewable resource sellers and buyers in validating purchases and sales of power that is 100 percent renewable. The Green Exchange Service confirms green power purchases and sales by participants scheduling through the CalPX. Sellers and buyers can use the Green Exchange Service confirmation to support claims for CEC credits or that certain power purchased or sold through the CalPX was green.

The Green Exchange Service is a verification service only and is not actually an exchange. Rather it allows certified buyers and sellers to exchange wholesale power over the PX and negotiate on their own a bilateral contract for the “green” attributes of the power. Through its other exchanges, the CalPX facilitates the trading and reporting on power transactions, coordinates the schedules and deliveries, and provides a web-based forum for buyers and sellers to find each other. But because CalPX doesn’t actually operate a market for green power, they do not report on the differences between the costs of commodity and green power.

Automated Power Exchange (APX)

The Automated Power Exchange (APX) operates an alternative exchange to the CalPX. The APX connects buyers and sellers of both renewable and non-renewable power, and is a registered scheduling coordinator with CAISO.

APX Markets

APX offers a continuous market for hourly energy, daily on- and off-peak strips, monthly blocks, and four-hour blocks.

- ? The APX Hourly Energy market accepts bids on a day-ahead and hour-ahead basis. Day-ahead markets close at 9:30 a.m., while hour-ahead markets close two and a half hours before dispatch.
- ? The Daily On- and Off-peak Strip markets allow market participants to bid straight production during all on-peak (7 a.m. to 10 p.m.) or off-peak (11 p.m. to 6 a.m.) hourly blocks with a single bid. These markets close at 9:30 a.m. for day-ahead bids, and at 4:30 a.m. for hour-ahead bids on the day of delivery.
- ? The Monthly and Four-hour Block markets began operating in January 2000 and operate similarly to the CalPX’s Block Forward market.

APX Green Power Market

In May 1999, APX started green ticket trading through its Green Power Market. This market allows wind and other green resources to sell their power into the commodity energy markets described above and earn a separate “green ticket” for each MWh of green power generated. Generators can then sell these green tickets on the Green Power Market to collect a premium that represents the “green” attributes of the power generated, without having to forecast ahead of time how much they will be generating. As shown in Table

¹¹ Interview with Hap Boyd, Enron Wind, August 25, 2000.

1, below, the market premium for power sold through the Green Power Market has averaged about \$4.00 per MWh (or about four tenths of a cent per kWh) in 2000.

Table 1. APX California Green Power Market Prices, Year 2000¹²

Month	Average \$/MWh	Monthly High \$/MWh	Monthly Low \$/MWh	Monthly Volume in MWh	Cumulative Volume Weighted Average \$/MWh
January	4.38	8.75	2.50	9,551	4.38
February	3.90	6.00	3.00	14,600	4.09
March	4.31	4.75	3.50	57,026	4.25
April	3.28	3.50	0.50	19,816	4.23
May	3.42	4.00	2.75	51,645	4.10
June	3.35	4.80	2.00	202,897	3.98
July	3.67	45.00	1.00	127,648	3.85

Note: Prices reflect the value of green tickets only, and not the total price of green energy.

Green ticket revenues go directly to generators of the power. The green ticket concept allows retail energy providers the option of buying green tickets forward to lock in the price of green power. In this market, "green tickets" can be bought and sold on an annual basis.

APX Green Tickets are differentiated by technology type, plant vintage (existing or new), and California Energy Commission (CEC) credit eligibility. Following CEC guidelines, only energy provided from wind, solar, geothermal, biomass, landfill gas, and small (less than 30 megawatt) hydro power plants may be sold into the APX Green Power Market. APX is a wholesale member of Green-e, and green power sold through APX is eligible for a 1.5 cent per kWh incentive from the CEC's Customer Credit Subaccount, described in Appendix B.

Most of the power being sold in the APX Green Power Market is derived from geothermal, biomass, landfill gas, and other resources. Nearly all of the independent renewable energy producers that can sell into California's open market, including Calpine Corp., Burney Forest Products, and Enron Wind Development Corp., sell green power through the APX Green Power Market. Renewable energy generators have indicated a preference for the APX market over the CalPX because of its more flexible scheduling options and its operation of a true exchange for green energy credits. As a registered CAISO scheduling coordinator, the APX also can aggregate the varying characteristics of renewable generators, mitigating the risks of intermittency through diversification of resources.

Comment: A good write-up of the APX. One other thing to note is APX offers much more flexible scheduling than the PX, from a hourly to weekly to monthly basis. The APX is also a scheduling coordinator on the ISO (and I believe the PX as well), so they can effectively "aggregate" the varying characteristics of renewable generators. See former APX staffer Jan Pepper's papers to Windpower 1998 and Windpower 2000. We may have it on the Green Power web site at <http://www.eren.doe.gov/greenpower>. [I've added some discussion to address these points. SMW]

Categories of Wind Capacity in California

California's existing and new wind facilities can be grouped into three main categories, each of which faces a unique set of options, opportunities, and obstacles for selling generated power. These categories are:

- ? Capacity operating outside of California's competitive markets, primarily existing capacity operating under long-term contracts with IOUs;
- ? New and existing capacity operating in California's competitive markets, such as new capacity that has been built to supply power to consumers of green power; and,
- ? Future capacity that will operate in California's competitive markets, such as new capacity and existing capacity that is coming off existing long-term contracts.

While most attention is focused on the development of competitive wind facilities in California, it should be noted that the vast majority of wind power capacity in California currently operates outside of competitive markets but strongly influences available markets for new competitive facilities. As long-term

¹² http://www.apx.com/sGr_html/sGr_2.html

wind contracts with IOUs expire or are voluntarily terminated, California's existing wind capacity will be forced to compete with new wind and other generation resources in competitive markets.

The next sections discuss how wind facilities in each of these categories operate in California, elaborate on the opportunities and obstacles faced by wind generators, and identify lessons learned relevant to CAISO and RTO formation generally.

5. WIND OPERATING OUTSIDE OF COMPETITIVE MARKETS

Most existing wind capacity in California currently operates outside of the state's competitive electricity markets. This capacity primarily includes wind under long-term contracts with the state's IOUs, but also includes a small amount of capacity owned or contracted for by municipal utilities. The following sections describe how this capacity is currently operated and regulated in California.

Existing Wind Capacity under Standard Offer Contracts

California has approximately 1,800 MW of existing wind capacity, of which approximately 1,700 MW is operating under long-term standard offer contracts signed with the state's IOUs in the 1980s and early 1990s. Typically, these contracts were 30 year commitments that provided wind developers with a high fixed price per kWh for the first 10 years of operation (often in the range of 10-15 cents per kWh), and an additional 20 years at the IOU's variable short-run avoided cost (SRAC) rate.¹³ Many of these contracts also provide capacity payments to wind generators. By the end of 2001, all of these contracts will have reached the SRAC period.

The IOUs forecast production of standard offer wind facilities based on historical data and predicted weather conditions, then schedule it through the CalPX as "regulatory must-take" generation. They then have the ability to adjust the scheduled generation in the CalPX's day of market scheduling in order to reflect the most recent generation forecasts. The CalPX forwards these schedules to CAISO, and if the project's actual operations do not match the schedule the IOU must either back up the wind with other generating resources or is must pay the costs of correcting its uninstructed deviations.

This arrangement allows existing wind facilities to continue operating without bearing the risks associated with scheduling power into available markets. Rather, these scheduling risks are shifted to the IOUs. For existing wind facilities that have reached the SRAC contract period, there are still price risks, but these risks are mitigated during the transition period through the CEC's Existing Resources account, which provides wind operators with incentive payments that allow them to earn as much as 3.5 cents per kWh.

Operators of wind plants that are now or will soon be in the 20-year SRAC period could choose either to remain in their standard offer contracts and continue to earn their IOU's SRAC (plus CEC incentive payments for existing resources, when applicable), or could attempt to negotiate an IOU buyout of the contract. Remaining in the standard offer contract would have several advantages, including:

- ? Price stability with CEC incentive through the transition period (and perhaps beyond, if incentives are extended),
- ? Long-term obligation by IOU to purchase energy,
- ? Ability to retain existing transmission rights, and
- ? Continued assumption of scheduling risks by the IOUs.

The major disadvantage of remaining in standard offer contracts is that the IOU's SRAC or 3.5 cents per kWh may not be enough revenue to sustain wind facilities that are based on older, less efficient technology. Wind operators may also be interested in repowering existing facilities with newer, more efficient equipment that would increase capacity and energy production at existing sites. In order to do so, however, wind operators would need to negotiate new contracts for the additional capacity and energy production, and in some cases would need to arrange for increased transmission capacity.

¹³ Interview with Tony Goncalves, California Energy Commission, August 28, 2000.

In addition, by remaining in their standard offer contracts wind generators must relinquish perceived opportunities to earn potentially higher returns in competitive or green energy markets. During the summer of 2000, when market prices were particularly volatile in California, wind facilities may have fared better at times by selling directly into the CalPX or APX market than they would have by earning the utility's SRAC, but it is not at all clear that this result could be expected over the long term.

Municipally-Owned Wind Capacity

In 1994, the Sacramento Municipal Utility District (SMUD)¹⁴ installed a 5 MW wind facility to supply power to its "Greenergy" voluntary green power program.¹⁵ SMUD has a transmission contract with PG&E to transmit the wind power through an existing PG&E line to a substation in its service area, and SMUD accepts the energy as it is generated. The project is eligible for and receives the federal renewable energy production incentive, but is not eligible to receive any CEC incentives.

Since SMUD owns the wind generation and transmits the power to its own service territory, CAISO's involvement in this transaction is limited to the transmission along the CAISO-controlled line. In this case, the transmission reservation between SMUD and PG&E is simply set aside and ignored by CAISO. Other transmission transactions regulated by CAISO can take place on the remaining capacity on the line, and if there is congestion, CAISO can suggest solutions that affect those parties involved in the congestion.

SMUD is currently in the final stages of selecting a contractor to expand this facility by another 30 MW. But rather than owning the new wind generators itself, SMUD is looking for a wind developer to own and operate the new 30 MW and offer the energy to SMUD under a bilateral contract.

In similar fashion, California's other large municipally-owned utility, the Los Angeles Department of Water and Power (LADWP), approved in August 2000 a contract with Enron Power Marketing to supply new wind energy to the Green Power for a Green LA program.¹⁶

It is possible that additional wind projects could be developed in California outside of competitive markets; these projects could include new capacity owned by, or energy purchased by, utilities exempt from competition such as municipally-owned utilities, public power districts, and rural electric cooperatives

Opportunities and Obstacles

Wind facilities in standard offer contracts have the opportunity to remain in their contracts, earning at least the IOU's SRAC plus CEC incentive payments while transferring scheduling risks to the IOU. Remaining in their contracts would also allow them to keep their transmission reservations through the duration of the contract. However, operators of wind facilities in standard offer contracts point out that these facilities are based on older wind technology that is less efficient than current wind technology. They argue that they may not be able to sustain these facilities on the IOU's SRAC, or even on 3.5 cents per kWh under the CEC incentive program, and must overcome significant barriers to justify investments in newer generating technologies that could increase energy production at these sites. They believe that as investments increase in new generating facilities in California, the IOU's SRAC could be driven even lower, making it more difficult for them to compete.

¹⁴ Under California's restructuring legislation, municipally- and customer-owned electric utilities retained the ability to choose whether to offer competitive electric services and thereby open their own service areas to retail competition. To date, the state's two largest municipal utilities, the Los Angeles Department of Water and Power, and the Sacramento Municipal Utility District (SMUD) have elected to remain outside of the competitive retail arena.

¹⁵ Due to technical problems with several of the wind turbines at the site, the SMUD project is now operates at a rated capacity of 4 MW. Interview with Paul Olmstead, SMUD, August 28, 2000.

¹⁶ DWP Purchase of New Wind Energy for Green Power Program Approved by Board, press release of August 3, 2000. Available at http://www.greenla.com/green_power/green_power.htm.

CAISO/RTO Lessons Learned

California has a huge base of existing wind facilities operating outside of its competitive markets. Most of these facilities are based on older, less-efficient technology that simply will not be sustained in competitive markets. While maintaining a policy goal of promoting development of competitive markets, California has taken two approaches to sustaining existing wind facilities during the transition period.

- ? *Accommodate existing wind through IOUs.* California has accommodated existing wind by requiring IOUs to honor their long-term contracts with developers of existing wind facilities. This accommodation is valuable in that it frees wind developers of the risks of scheduling wind generation and preserves their access to transmission. However, since most of the standard offer contracts have moved into a period of variable prices based on the IOU's SRAC, there may not be enough price incentive for existing wind facilities to continue operating under these contracts.
- ? *Stabilize prices for existing wind.* California has attempted to maintain price stability for existing wind facilities through the transition period by providing CEC incentive payments that essentially guarantee existing wind facilities a price of 3.5 cents per kWh.

Two lessons can be learned about California's strategy for existing wind facilities in restructured markets.

- ? First, both of these solutions are intended to shore up existing wind through the transition period, but are not designed to sustain existing wind in the competitive era that is to follow.¹⁷
- ? Second, neither of these solutions is rooted in or otherwise involves CAISO. CAISO has been designed to facilitate the reliable operation of open, fair, and competitive markets; where these markets fail to support forms of generation that are environmentally or socially preferable, the state has turned elsewhere for remedies.

6. WIND OPERATING IN COMPETITIVE MARKETS

To date, only two new wind plants—totaling just 18.6 MW of capacity—are operating in California's competitive electric markets. Both sell their output under bilateral contracts; one to an affiliated power marketer, the other to a retail green power provider. The following sections describe how these projects operate.

Current Capacity Operating under Bilateral Contracts

Bilateral contracts are direct contracts between a wind energy developer and a power marketer, energy service provider, or customer. Under a bilateral contract, the buyer will combine wind with other generation resources to create a blended product or set of products that meet certain criteria, and will sell the product either into available markets or directly to consumers. Under a bilateral contract, the buyer assumes some or all of the risks associated with wind's intermittency. Since power marketers or energy service providers can blend wind with a diversified portfolio of complementary resources, they may also have the ability to reduce or mitigate a portion of these risks.

Settlement transactions under a bilateral contract are handled directly between the buyer and seller without a power exchange acting as an intermediary. The physical transfer of power is still visible to CAISO, however, which is involved in scheduling the transmission, reserving capacity, managing congestion, and settlement of unscheduled deviations. However, the scheduling coordinator responsible for the bilateral contract would shield wind developers from dealing directly with CAISO.

Both the Enron and SeaWest new wind plants operate under this scenario, selling all of their output to Enron Power Marketing and Green Mountain Energy Resources, respectively. The energy from the Enron plant is mixed with and backed by Enron's other generating resources and is sold to Enron's California

¹⁷ As of this writing, the California legislature is considering legislation that would extend the CEC price support program for an additional four years.

energy customers.¹⁸ Enron has several large retail customers in California as well as some residential customers, and mixes their wind power into Enron Power Marketing's portfolio of resources. The energy from the SeaWest plant is mixed with energy from other resources and sold as green power to Green Mountain's California energy customers.

The Enron plant has begun receiving incentive payments from the CEC's New Resources account, and the SeaWest plant is scheduled to begin receiving payments "imminently."¹⁹ An additional 280 MW of new wind is scheduled to come on line and begin receiving CEC incentive payments by the end of 2001. It is not yet clear whether these plants will sell their power under bilateral contracts or through an exchange.

Opportunities and Obstacles

Wind developers who can negotiate bilateral contracts can gain advantages of price stability and mitigation of scheduling risks. Power marketers or other buyers of wind energy in bilateral contracts may assume the scheduling risks associated with wind's intermittency, but often are in a better position to mitigate these risks by having knowledge of, and relationships with, other generators who can back up wind generation as needed. In this respect, Enron, with its knowledge of gas markets and its ownership of gas generating resources, is an ideal power marketer for wind. The continued development of retail green power markets in California may become a further driver of new bilateral contracts for wind.

At the same time, there are a number of obstacles to continued development of bilateral contracts for wind in California. For example, the number of power marketers with available resources to back up wind's intermittency may be limited. While Enron is in a good position to market wind energy, the company also is vertically integrated with its own wind equipment manufacturer, Enron Wind, and may choose not to market or back up the power from competitive wind generators. In addition, due to the continuing challenge of integrating intermittent resources like wind into California's power markets, and to the difficulties faced by green power retailers in encouraging California's customers to switch to green energy providers, wind generators may experience difficulty in negotiating bilateral contracts with terms long enough to justify long-term investment in new wind generation equipment.

CAISO/RTO Lessons Learned

New wind capacity has been slow to develop in California since restructuring: to date, only 18.6 MW of new capacity is online, though an additional 280 MW is planned. Although the state has adopted a restructuring strategy that promotes development of efficient power markets, wind developers have not yet found a way to participate directly in these markets. The state also has provided incentives to new wind developers and customers who choose to purchase energy from renewable resources. California's two strategies toward new wind resources can be summarized as follows:

- ? *Facilitate development of forward and real-time markets.* California has promoted development of bulk power markets by creating the CalPX and by allowing other competitive power exchanges to form. The state also has encouraged formation of separate green power exchanges by certifying renewable generation. In general, these bulk power markets have been encouraged to adopt rules that are blind to the form of generation and that avoid arbitrary penalties for under- or over-supply. The same philosophy dominates the design of short-term and real-time ancillary services markets run by the CAISO, although low levels of participation by energy providers have challenged the efficient operation of these markets.

¹⁸ The Enron project is called Green Power I, and is located east of the city of Palm Springs. The power purchase agreement was signed in April 1998, and the project was completed in June 1999. The facility consists of 22 Zond 750 kW wind turbines.

¹⁹ The SeaWest plant is operating but is being sold to PacifiCorp. The transfer of ownership has caused delays in filing documents needed to begin receiving incentive payments from the CEC. CEC expects the problems to be resolved in time for the plant to begin receiving incentive payments in the third quarter of 2000. Interview with Suzanne Korosec, California Energy Commission, August 24, 2000.

- ? *Subsidize new renewables.* During the transition period, California has provided generation incentives for developers of new wind facilities as well as customer credits that lower the cost of green power for customers who choose it

While some non-intermittent forms of renewable energy generation have begun selling power into California's power exchanges, to date no wind developers have been convinced that selling their energy into the markets is preferable to selling under a bilateral contract. The following lessons can be learned about California's experience with new wind capacity.

- ? New wind capacity has been slow to develop under California's restructuring policies, and that which has been developed operates exclusively under bilateral contracts, in which the risks associated with forecasting and scheduling wind power are largely transferred to the buyer. No new wind facilities currently are selling power directly into the state's competitive power exchanges.
- ? CAISO policies have not been instrumental in the development of the state's two new wind facilities. Both new facilities were developed before CAISO's new 10-minute markets went into effect. Enron backs up its 16.5 MW wind plant with other Enron generating assets, avoiding the need to rely on CAISO's ancillary services markets for balancing. Similarly, in the 2.1 MW SeaWest/Green Mountain project, the risks of wind's intermittency are largely assumed by Green Mountain.
- ? California's redesigned real-time market may provide a new opportunity for wind generators to sell all or a portion of their energy as uninstructed incremental deviations; however, wind generators would more likely earn lower prices for their energy in this market than they would by scheduling ahead or bidding into and acting on instructions in the real-time market.
- ? The availability of state and federal incentives for new renewable generation and customer credits for purchasers of green power have driven development of new wind facilities during California's transition period. The availability of these incentives is entirely independent from the operation of CAISO or the power exchanges.
- ? CAISO's continuing work on increasing participation in bulk power and ancillary services markets may be important to future wind capacity in the state, including new wind capacity as well as existing capacity released from standard offer contracts.

7. BEYOND BILATERAL CONTRACTS

While California's two new wind facilities operate under bilateral contracts, it is possible that future wind facilities will seek to sell their power under bilateral contracts or sell it directly into competitive markets. The largest category of wind resources in California that will be forced to sell power through bilateral contracts or to competitive markets is existing capacity released from standard offer contracts, but other new wind facilities would also have these options.

Existing Capacity Released from Standard Offer Contracts

All standard offer contracts for wind eventually will expire. As wind facilities come off these contracts, they will need to find other avenues to continue selling their power, and more than likely will be required to mitigate the risks associated with intermittency on their own. Almost all of this existing capacity in standard offer contracts will have reached the end of its fixed price contract period and will have entered the SRAC period by the end of 2000.

For those few wind plants that are still receiving fixed payments from IOUs, the best option is to continue receiving these payments. As long as the fixed price payments are higher than market rates, these wind plants would continue to earn above-market revenues while offsetting market and scheduling risks to the IOUs.

An alternative option is to negotiate an IOU buyout of the existing standard offer contract. In this case, the IOU would pay the wind developer for the right to terminate its must-take contract. This option is discussed in more detail in the next section.

Advantages of Terminating Standard Offer Contracts

It is possible that wind developers would seek to be released from unprofitable long-term standard offer contracts in order to gain more flexibility in how, and to whom, they sold their wind energy.

Some other renewable energy generating plants have been released from existing standard offer contracts in the past few years, including plants that rely on non-intermittent resources such as biomass and geothermal energy, but to date no wind power plants have done so.²⁰ Those plants that have been released from their standard offer contracts are still eligible to receive CEC incentive payments, though the payments are calculated based on CalPX rates rather than on the IOU's SRAC. It is probable that wind plants also would be eligible to continue receiving CEC incentive payments.

A potential side benefit of releasing wind plants from their standard offer contracts could be increased capital investment at existing wind sites. Under existing standard offer contracts, wind developers have had little incentive to increase generating capacity at their sites by installing newer, more efficient generating equipment because the contracts specify the amount of capacity that is to be provided.

Disadvantages of Terminating Standard Offer Contracts

The disadvantages associated with terminating wind energy standard offer contracts have simply made pursuing release from the contracts an economically unacceptable option. These disadvantages would include the loss of a long-term power purchase commitment (and the need to replace it with either a new commitment or a viable strategy for selling power into an exchange), the need to assume risks and costs associated with forecasting and scheduling wind into markets, and the need to renegotiate transmission rights. A wind plant desiring to sell into competitive markets would need to overcome these obstacles and negotiate sufficiently favorable standard offer contract buyout terms.

If a wind plant were to be released from its standard offer contract, it would have two options for selling its output. It could either: 1) enter into bilateral contracts with power marketers, green power providers, distribution utilities, or load aggregators such as municipalities, large energy consumers, and other entities, or 2) sell directly into a power exchange and/or CAISO short-term markets.

New Capacity Selling Directly into Exchanges

For new wind facilities and facilities coming off their standard offer contracts, a second option is to sell wind energy as commodity power directly into an exchange such as the CalPX, APX, or the restructured CAISO real-time market. Unfortunately, due to the difficulties associated with accurately forecasting wind generation, these options present significant financial risks. While the new CAISO real-time market may allow wind generators to mitigate these risks by moving the bidding deadline to within 20 to 40 minutes of the applicable 10-minute block, it is unknown whether that market will attract sufficient and consistent demand to accommodate available wind supplies. In addition, this option carries risks associated with paying CAISO to back up the wind facility's uninstructed deviations with reserves.

Selling wind energy into commodity markets effectively strips the energy of its potentially valuable "green" attributes, but the new verification services provided by CalPX and the "green ticket" markets provided by APX provide a means for wind operators to recapture the value of these attributes apart from the energy itself. The green tickets can be sold separately through bilateral contracts or through a green exchange to power marketers or retail energy providers who need them to back up their claims. The net effect is to present green power generators with a larger potential market into which they can sell their energy.

To date, no wind facilities in California are selling power directly into an exchange. If wind generators were to sell into an exchange, they would need to be strategic in their decisions about how far forward to

²⁰ Interview with Tony Goncalves, California Energy Commission, August 30, 2000.

sell their power. An example of a hypothetical bidding process for a wind resource in California is presented in Appendix D.

Opportunities and Obstacles

Several characteristics of the California markets support development of wind facilities that bid their power directly into power exchanges. These characteristics include:

- ? *The existence of short-term forward markets.* The CalPX's day-of, hour-ahead markets, the APX's hour-ahead markets, and the CAISO real-time imbalance markets all provide opportunities for wind to schedule or bid generation based on forecasts that are made just 1-4 hours prior to the operating hour. These short-term markets allow wind operators to schedule or bid power more reliably based on more accurate short-term forecasts.
- ? *Market-based cost allocation for imbalances.* Rather than impose arbitrary penalties on generators that do not precisely follow their schedules, CAISO's new 10-minute markets use a strategy of allocating the market costs of correcting imbalances to the generator or generators who caused the imbalance. This provides financial incentives for generators to follow their schedules, and does not unduly penalize imbalances.
- ? *Anonymity of buyers and sellers.* Since buyers and sellers in power markets are anonymous to one another prior to the settlement, the power exchanges may provide wind operators with an opportunity to avoid finding specific buyers for wind energy and its green attributes under bilateral contracts. In addition, California's green power credit trading system allows wind and other renewable energy developers flexibility to sell their commodity energy and its green attributes to separate customers in separate markets or contracts.
- ? *High prices for real-time incremental energy.* Although price spikes in California's energy markets during summer 2000 were often characterized as the result of inefficient markets, such markets can present short-term opportunities for resources that are already in place or can be deployed quickly, including wind.
- ? *Subsidies provided by the CEC's Renewable Energy Program.* These subsidies provide new and existing wind and other renewable energy facilities with subsidized and more stable prices for their products through the transition period. They also provide discounts to customers who choose green power providers, and may drive demand for green power by making green energy less expensive.

Despite these advantages, no wind operator in California to date is selling power directly into the exchanges. There are a number of obstacles that limit the ability of wind generators to do so. These include:

- ? *Wind's inherent intermittency.* Intermittency makes wind difficult or impossible to bid ahead reliably in forward markets. CAISO's new 10-minute market may provide an avenue for wind to bid incremental energy on a short-term basis or sell energy as uninstructed positive deviations.
- ? *Decreasing value of green credits.* In trading on open exchanges over the past year, the green power premium in California markets has gradually decreased, from about 0.44 cents per kWh in January 2000 to less than 0.39 cents per kWh in July 2000.
- ? *Low average prices for energy.* Despite price spikes that have captured media attention during summer 2000, average prices for energy in the California markets have remained low – too low to support many existing wind facilities as well as some new ones.
- ? *High prices for reserve energy.* Poor participation in California's ancillary services markets means wind generators need to turn to expensive reserve energy for backup. As CAISO encourages higher levels of participation in the ancillary services markets, these prices may decline.
- ? *Limitations on development of green power markets.* Due to pricing policies and surcharges during the transition period, competitive power suppliers in California have had a difficult time differentiating their products based on price. Also, default service provisions specify that customers who do not actively switch power providers remain with the IOU. These factors have

provided disincentives to California consumers for switching energy providers. There is evidence that the market for green power could be much larger in California if customers had more incentive to switch providers. In the state's first year under restructuring, only 1 percent of customers switched providers, but of these, about 75 percent switched to a green energy provider.

- ? *Competition with existing renewable resources.* New wind capacity in California must compete with both new and existing sources of renewable energy. Although the CEC's green ticket program differentiates green tickets by whether they come from new or existing facilities, it will be up to consumers to decide whether energy from new resources is worth more than energy from existing resources. Both new and existing renewable resources can be marketed as "green" in California. This includes the 1,700 MW of existing wind currently in long-term contracts with IOUs, as well as other existing renewables, such as geothermal and biomass facilities, that could compete with new wind.
- ? *High credit requirements for trading.* The CalPX and APX both require credit requirements of traders that might exclude small resources such as wind from being able to participate.
- ? *Transmission capacity reservation requirements.* In California, intermittent resources such as wind either need to pay to reserve full capacity on transmission lines (and risk producing less than full capacity), or play only in imbalance markets where capacity reservations are not required.
- ? *Transmission constraints.* Transmission constraints currently limit expansion of wind power capacity in California's Tehachapi region.

CAISO/RTO Lessons Learned

Wind energy developers have not yet found a profitable or reliable way to sell their product directly into California's power exchanges. Wind energy remains challenged in these exchanges by a number of factors, many of which are outside the control or scope of the CAISO. Several observations can be made about CAISO's experience with new wind energy.

- ? Many of the factors limiting wind energy's ability to compete in California's energy markets are beyond CAISO's control or scope.
- ? The California power exchanges and CAISO together offer generating resources a range of forward bidding opportunities, including day-ahead, hour-ahead, and 10-minute markets, as well as a market for uninstructed real-time energy. This range of forward and real-time markets gives maximum flexibility to intermittent resources such as wind that are difficult to forecast reliably.
- ? Many wind developers view CAISO's new real-time markets, with their adherence to market-based solutions for generation that deviates from commitments, as a promising opportunity in which to sell wind energy.
- ? The mere existence of market-based strategies for alleviating transmission problems does not guarantee efficient market outcomes. Markets themselves need to have high levels of participation in order to function efficiently and deliver energy services at low prices.
- ? Even where markets do function efficiently, wind's intermittency may result in discounted prices for energy or limited opportunities to sell power into available markets

8. FERC ORDER 2000 EFFECTS ON CAISO

FERC Order 2000 requires all public utilities that own, operate or control interstate electric transmission to file a proposal addressing the utility's participation in a Regional Transmission Organization (RTO). Public utilities already in a FERC-approved RTO, such as CAISO, must file with FERC how the RTO does or does not comply with Order 2000, and offer any amendments or changes to comply with Order 2000. FERC has said well-designed RTOs could improve transmission grid management; improve grid reliability;

eliminate discriminatory transmission practices; improve market performance; and help provide for light-handed regulation.²¹

CAISO officials generally believe the organization already complies with Order 2000, but are moving forward with several adjustments to the CAISO tariff and operating guidelines. The most important issue that directly pertains to Order 2000 requirements concerns RTO coverage and seams issues. In Order 2000, FERC advocated for more regional governance of transmission systems. One option would be for CAISO to merge with or provide services to neighboring RTOs, such as the Desert Star ISO in the Southwest and RTO-West in the Northwest. CAISO has made open offers to both regions to provide ISO services, but neither region has accepted these offers. Combining CAISO's operations with other regions would require the California legislature to modify certain laws that govern CAISO, and the California legislature appears willing to make the needed changes. For example, FERC is interested in the governance of the CAISO and has requested several changes that would remove State influence in the wholesale part of the market. FERC also would like to see more regional input into the operations of the CAISO.

There is a growing perception, fueled in part by California's turbulent market prices during the summer of 2000, that CAISO must evolve in a manner that recognizes and addresses the regional, interstate nature of the transmission system. According to Jan Smutny-Jones, CAISO chairman,

"There is a perception somehow that there are separate markets. There's a California market and an Arizona market and a Nevada market. The fact... is that we kept the lights on today in California because there's an interstate market. We ought to be looking for opportunities ... to begin looking at these issues on a regional basis."²²

It is highly unlikely that CAISO will ever merge with or otherwise become responsible for the operation of large areas of the Western Interconnection. RTO-West and Desert Star are now well into their formative processes and are preparing FERC filings to become RTOs in their respective regions. Therefore, seams issues affecting the interface between different western RTOs will be of primary interest to competitive energy suppliers and wind developers in the West.

9. OTHER AREAS OF CURRENT WORK AT CAISO

CAISO is currently working in a number of areas to address issues that have arisen. The most pressing of these have to do with creating more efficient power supply markets.

- ? *Price caps.* Probably the major area of concern at CAISO is price caps. The generation market in California is known to be tight on high demand days, so CAISO and the exchanges have set price caps in order to protect consumers from extremely high prices. The CalPX's price cap is set at

²¹ Prior to Order 2000, FERC had required in Order 888 that interstate transmission owners, typically utility companies that also owned generation, provide open access to their transmission facilities to other generation owners. Order 888 was intended to promote competition in the generation sector, and although utilities developed open access policies (tariffs, interconnection rules, etc.) that satisfied the requirements of Order 888, many independent generators still viewed these policies as being insufficient to promote competition. In particular, critics objected to the fact that utilities still exercised full control over the governance and operation of their transmission systems. In addition, distributed and intermittent resources would have difficulty taking advantage of open access transmission tariffs because of various terms and conditions designed more for larger-scale generation resources. Critics also objected to the fractured governance and operation of the transmission system that continued after Order 888, and to the existence of utility-by-utility tariffs that required independent generators to pay multiple transmission fees to multiple transmission owners in order to transport power through or within a small region. In response to this criticism, FERC issued Order 2000 to regionalize transmission governance and operation and to functionally separate it from transmission ownership.

²² Restructuring Today, August 2, 2000.

\$2,500 per MWh, while CAISO's price cap is much lower at \$250 per MWh.²³ Many argue that this differential creates an incentive to scheduling coordinators to underestimate projected loads to CalPX, and when the actual load turns out to be higher, supplementary power may be procured through the CAISO at lower prices. Of course reliability suffers when power has to be acquired on very short notice. FERC would prefer to see all price caps removed. Many state legislators want to lower the price cap to further insulate consumers from price spikes and instability.

- ? *Minimizing risks of uninstructed deviations.* Another area that may be pursued is the development of policies specific to intermittent renewables that would minimize the financial risks associated with uninstructed deviations. "Assuming that these types of resources do not make up a significant proportion of the total supply in any hour, and assuming social policies favor non-combustion generation technologies, the ISO should be able to bound the risk exposure associated with these resources."²⁴
- ? *Ancillary services market efficiency.* Profits from generation in California are low enough that it is not encouraging high levels of participation in ancillary services markets. Therefore prices for peaking capacity and ancillary services likely will remain in short supply during high demand periods.
- ? *Long-term planning.* CAISO is also making some changes to the way in which long-term planning is conducted. The idea is to coordinate better with what is happening in real-time. It is felt that some entities have been taking advantage of loopholes in the system for their own advantage and to the detriment of reliability. This is further discussed in the paragraph below on price caps. "We have turbines on our site right now that we could use but we can't because there isn't any way to deliver the electricity." Oak Creek Energy president Hal Romanowitz. Oak Creek generates about 5 percent of the power produced in the Tehachapi area. His current contract with SCE terminates in 2001.²⁵
- ? *Must-run generators.* Another issue being discussed in California is how to handle "must-run" generators. These are generators that, for reliability reasons, must be on line when they are not the most economical choice to run. In a true free generation market, they would not be contracted to run since they are not part of the lowest cost mix of generation required to meet demand. Some method of paying them to run out of economic order must be worked out within the context of a free market system.
- ? *Interconnection requirements.* One area that is ambiguous concerns modernization of existing facilities and utility efforts to require new or elevated interconnection costs. There appears to be a gap in the rules that apply for existing projects that modernize or ones that are coming off their long-term contracts. According to one attorney that represents wind power companies in California,

"We are aware of instances where a utility, under its Wholesale Distribution Access Tariff (WDAT), requires a project coming off its long-term contract to apply for an interconnection study as if it is a new greenfield project. The utility has asserted that – despite the absence of any physical change of the system – distribution system and transmission system capacity is not present with the change of contractual relationship."

Unfortunately the CAISO tariff is silent on the notion of transmission access for existing projects as well as repowers. Given that upgrades of turbines can significantly increase the output per acre, one should expect this issue to be an area which wind, as well as other facilities in long-term contracts with IOUs, would like corrected.

²³ The CAISO price cap has varied between \$250 and \$750 per MWh during summer 2000 in response to high prices on demand days.

²⁴ Interview with Andy Brown, Ellison,

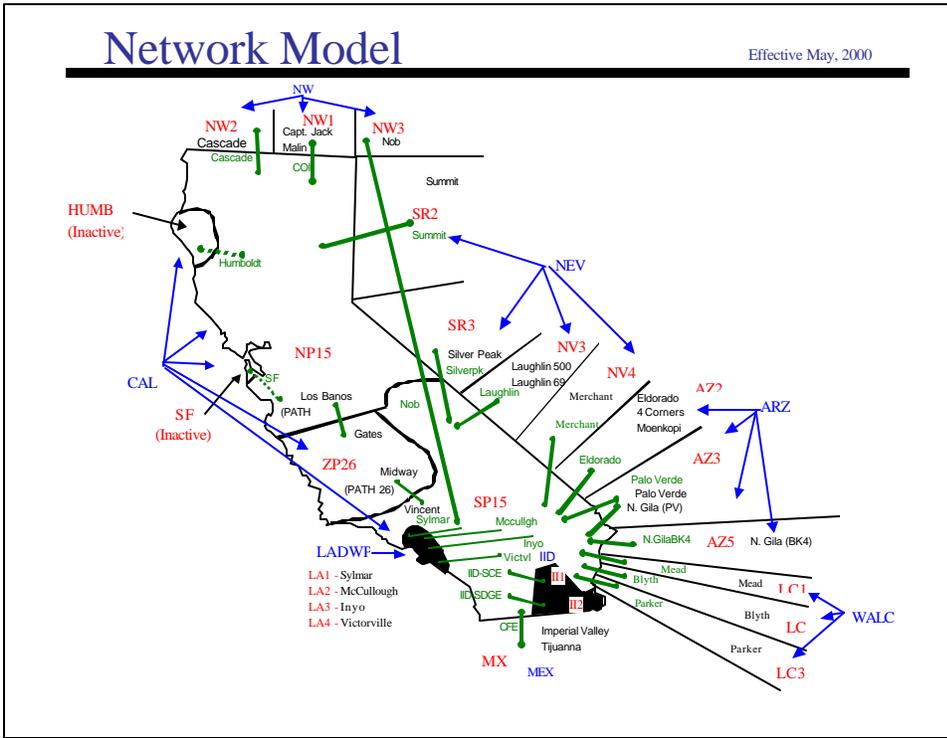
²⁵ Renewable Energy Today, August 8, 2000.

10. CASE STUDY CONCLUSIONS

California led the way in the U.S. towards competitive energy markets and ISO governance of the transmission system. Others can learn from the successes and failures of the California experience. CAISO has proven that an ISO can successfully run the transmission system in a region. Some changes will need to be made in California to smooth the process of meeting peak loads with limited generation. Along with this comes the need to lower the barriers between the California transmission system and that of neighboring regions. The following lessons can be learned on wind related transmission issues. These lessons are relevant to other RTO developments around the country.

- ? The existence of transmission policies that offer fair, market-based treatment of wind and other intermittent resources is a necessary but insufficient condition to drive development of wind resources in competitive markets. Also important are consumer demand for renewables and green power, market characteristics that allow consumers to exercise this demand, and the existence of efficient markets for ancillary services. RTOs may be limited in their ability to provide all the conditions necessary for the success of wind and other intermittent resources.
- ? California is now in the third year of its four-year transition period, and it may be too early to tell whether the state's restructured markets will support continued investment in wind generation. Transition period policies in California have not encouraged large numbers of consumers to switch energy providers, but it is possible that market conditions after the transition period will encourage more customers to switch, many to providers of green power.
- ? California's large base of existing wind capacity is a unique feature of the California market. This existing capacity may be forced to compete against new wind and other new and existing renewable energy capacity after the transition period ends. The result of this internal competition could be that less new wind capacity than expected is developed and many existing wind facilities fail.
- ? Wind's intermittency makes it difficult to schedule on a day-ahead basis, but the accuracy of generation models in predicting generation during a specified hour increases greatly as the specified hour draws near. Thus, wind resources may be well suited to submit reliable schedules into shorter term forward markets, like the day-of market operated by the CalPX or the hour-ahead market operated by APX. Similarly, wind resources may be able to reliably submit increment bids into California's real-time imbalance markets. These strategies may not be sustainable, however, because by the time the short-term markets are in effect, most resources are already committed, leaving wind with the possibility of not being able to enter the market if additional short-term demand is nonexistent.
- ? Adoption of policies that encourage RTOs to view intermittent generating resources in a similar manner as loads could benefit intermittent resources such as wind. There is inherent logic to the idea that wind and other intermittent resources appear to RTOs as variable and largely uncontrollable, much like loads; in fact, wind is often modeled by utilities as a negative load. If CAISO or other RTOs attempt in the future to accommodate load management services alongside generation resources, such accommodation may provide improved opportunities for wind and other intermittent resources to compete against generation resources on a level playing field. Wind interests could gain by closely monitoring RTOs' posture toward load management resources and by forming alliances with load management interests.
- ? CAISO policies have neither encouraged nor discouraged widespread development of new wind resources in California. Instead, the major drivers of wind development in California since restructuring have been speculation on the existence and abundance of green markets and the availability of state and federal incentives.

APPENDIX A: CALIFORNIA NETWORK MODEL AND CONGESTION ZONES



APPENDIX B: THE CALIFORNIA ENERGY COMMISSION'S RENEWABLE ENERGY PROGRAM

AB 1890 required California's IOUs to collect \$540 million from their ratepayers over a four-year period (1998-2002) to help support renewable energy generation technologies and develop a market for renewable energy. The California Energy Commission (CEC) is charged with administering the program, certain portions of which are directed specifically at funding wind energy projects, while others support a mix of generation technologies.

Existing Resources Account

The existing resources account was allocated \$243 million to support the continued operation of existing renewable energy facilities in California (these included biomass, solar thermal, waste tire, wind, geothermal, digester and landfill gas, small hydroelectric, and municipal solid waste facilities). The CEC allocated \$70.2 million of this account to existing wind projects specifically.

Eighty-four existing wind facilities with a combined capacity of approximately 1,500 MW have qualified to receive monthly incentive payments from the CEC.²⁶ The incentive payments are available to wind generators under existing contracts with IOUs, and guarantee that operators of existing wind plants will earn 3.5 cents per kWh by making up the difference, up to 1 cent/kWh, between 3.5 cents per kWh and the IOU's short run avoided cost (SRAC).²⁷ When the IOU SRAC is greater than 3.5 cents/kWh (as it has been frequently in summer 2000) these generators may receive no incentive payment from CEC. These incentives are available through the end of 2001, but legislative efforts are pending which would extend the program.

Due to high prices for energy in California's markets over the past two years, the Existing Resources Account has not paid out its full allocation at the rate that had been forecast. A proposal to allocate \$40 million in unused funds from the Existing Resources Account into the New Resources Account is now being considered by the CEC. It is described in more detail in the next section.²⁸

New Resources Account

The new resources account was established with \$162 million to support the development of new renewable energy facilities in California. CEC conducted an auction in 1998 in which all renewable generation technologies were eligible to compete. In the auction, developers bid a per kWh incentive rate (capped at 1.5 cents per kWh) and provided an estimate of their project's annual generation. CEC then selected the bidders with the lowest incentive rates and agreed to provide incentive payments for five years after the project startup date.

Twenty-one bidders were selected for funding, including seven wind developers who successfully proposed 24 separate wind projects with a combined capacity of approximately 300 MW. The successful wind bidders were: CalWind Resources, Enron Wind (4 projects), MarkTech/FORAS, Painted Hills Wind Development, Venture Pacific/SeaWest (15 projects), Whitewater Energy, and Windland.²⁹ An additional

²⁶ Interview with Tony Goncalves, California Energy Commission, August 28, 2000.

²⁷ As wind facilities come off their existing contracts with host IOUs during the transition period, they are still eligible to receive the incentive payments, but the payment amounts are based on CalPX prices rather than the host IOU's SRAC. Renewable Energy Program Quarterly Report to the Legislature, January 2000 through March 2000, California Energy Commission, April 2000.

²⁸ Notice of Proposed Changed to Guidelines for the Existing and New Renewable Resources Accounts of the Renewable Energy Program. October 11, 2000. California Energy Commission.

²⁹ Conditional Funding Awards under Notice of Auction 500-97-506, California Energy Commission, 1998.

wind developer, Cabazon Wind Partners, was later deemed eligible for funding after two other successful bidders (non-wind) cancelled their proposed projects.³⁰

To date, only two of the proposed wind projects are online, and only one has begun receiving CEC incentive payments.³¹ The first came online in 1999; it is a 16.5 MW plant located near Palm Springs operated by Enron Wind. The other project is a 2.1 MW facility built by SeaWest but since sold to PacifiCorp; it has not yet begun receiving incentive payments from the CEC, but is expected to shortly. The remaining 280 MW of wind projects are in various stages of development; all are meeting progress milestones and are scheduled to come online by December 2001.³²

The CEC is considering holding a second auction for new renewable resources in November 2000, funded by a reallocation of \$40 million of unused funds from the Existing Resources Account. The proposed second auction would offer \$40 million in incentive payments to new or repowered wind projects and other new renewable resources that become operational on or after October 11, 2000, and would contain bonus and penalty provisions for projects that meet or do not meet the CEC's deadline of July 1, 2001 for coming on-line.³³

Customer Credit Subaccount

The customer credit subaccount was established with \$75.6 million to provide credits to former IOU consumers who choose to purchase CEC-certified renewable energy from a green power supplier. The credits were originally valued at 1.5 cents per kWh, but the CEC lowered the credit amount to 1.25 cents per kWh in December 1999, and to 1 cent per kWh in June 2000. To date, there are 27 registered providers who participate in the program and offer customers 43 different qualified renewable energy products.³⁴

³⁰ Renewable Energy Program Quarterly Report to the Legislature, January 2000 through March 2000, California Energy Commission, April 2000.

³¹ Renewable Energy Program Quarterly Report to the Legislature, April 2000 through June 2000, California Energy Commission, July 2000.

³² Interview with Suzanne Korosec, California Energy Commission, August 23, 2000.

³³ Notice of Proposed Changed to Guidelines for the Existing and New Renewable Resources Accounts of the Renewable Energy Program. October 11, 2000. California Energy Commission.

³⁴ Renewable Energy Program Quarterly Report to the Legislature, April 2000 through June 2000, California Energy Commission, July 2000.

APPENDIX C: GREEN POWER CERTIFICATION PROGRAMS

California Energy Commission Certified Green Power

In order for an electric service provider to be able to offer its customers CEC customer credits for renewable energy, the sources of its power must be certified as renewable by the CEC. CEC requires such energy to be derived from generating facilities located in California that meet CEC's definition of "renewable".

Green-e Renewable Electricity Certification Program

The Center for Resource Solutions, a not-for-profit organization, established Green-*e* in order to encourage consumer confidence in buying green electricity. The Green-*e* logo is intended to provide a way for customers to easily identify green electricity products. The project is the nation's first voluntary certification and verification program for green electricity products. Among other criteria, the Green-*e* certification signifies to customers that at least 50 percent of the electricity supply for the product comes from renewable resources. Unlike the CEC certification program, Green-*e* does not require power to be generated within California.

APPENDIX D: EXAMPLE OF THE BIDDING PROCESS FOR WIND

A California wind operator might agree to generate power whenever it is possible to do so, counting on the existence of market prices that are high enough to enable recovery of costs and profit. The wind generator would bid forecasted capacity into the exchange at zero or a very low price and would probably be willing to take the market-clearing price, since any revenue would be preferable no revenue at all. This ensures that the power bid into the market will be sold, since it will be first in the market's bid stack. Since the wind operator has no fuel costs and low maintenance costs, the price bid into the market can be very low, and wind can compete with any other energy generating technology in this respect. The only problem is that the wind operator would never know exactly how much power to bid in because generation forecasts are never 100 percent accurate, even in the short term.

Preparing Bids for Day-Ahead Markets

A conservative wind operator of a 100 MW wind facility could schedule power as follows. First, on a day-ahead basis, the operator would forecast hour-by-hour generation for the following day. Understanding that there is uncertainty in this forecast, the wind operator would discount the forecast to achieve a higher level of certainty. For example, if the day-ahead forecast tells the wind operator that generation will most likely be 80 MW from 2-3 p.m. the following day (the 50 percent probability forecast in Table 2, below), the wind operator might bid only 35 MW into the CalPX or APX day-ahead market for that hour, comfortable that the probability of achieving 35 MW is forecast at 95 percent. This supply bid goes into the exchange with a zero ask price, and the wind operator accepts whatever the market clearing price is for that hour. Another entity purchases the power, and they arrange for transmission through CAISO.

Table D-1. Generation Forecast for Day-Ahead Market

Probability	Day-Ahead Generation Forecast for 1 hour
50%	80 MW
80%	50 MW
90%	40 MW
95%	35 MW

Preparing Bids for Hour-Ahead Market

The next morning the wind operator prepares for the APX hour-ahead market, which closes at 11:30 a.m., or two and half hours before the scheduled hour of 2-3 p.m. Armed with updated forecasts, the wind operator now sees the probability schedule shown in Table 3, below. With more recent weather information, the operator forecasts a 95 percent probability that the facility will be generating 65 MW from 2 to 3 p.m., 30 MW over that which was predicted in the prior day's forecast and sold in the day-ahead market. The wind operator submits a new bid in the hour-ahead market for 30 MW at an asking price of zero. The bid is accepted, the wind operator accepts the market-clearing price for that hour, and transmission is arranged through CAISO.

Table D-2. Generation Forecast for Hour-Ahead Market

Probability	Hour-Ahead Generation Forecast for 1 hour
50%	80 MW
80%	75 MW
90%	70 MW
95%	65 MW

Preparing Bids for the Real-Time Market

By 1:20 p.m., just 40 minutes before the scheduled hour of 2-3 p.m., the wind operator's forecast shows a 95 percent certainty that the facility will be producing 70 MW for the entire hour. This is 5 MW above the

65 MW the wind operator has already committed in the day-ahead and hour-ahead markets. The operator can therefore submit a bid to supply 5 MW of incremental power in each of the six 10-minute markets from 2-3 p.m.

Table D-3. Generation Forecast for 10-Minute Market

Probability	Hour-Ahead Generation Forecast for 1 hour
50%	76 MW
80%	75 MW
90%	73 MW
95%	70 MW

Real-Time Operation

In real-time operations between 2 and 3 pm, the wind blows softer than expected during the first twenty minutes of the hour and the wind plant produces just 65 MW. Production averages 70 MW during the second twenty minutes, and in the final twenty minutes the facility produces 75 MW.

Settlement

The wind operator’s day ahead bid of 35 MW and hour-ahead bid of 30 MW are covered. During the first two 10-minute intervals in the 10 minute market, the wind operator is unable to act upon CAISO instructions to produce the 5 MW bid into the market. CAISO must purchase this energy from its real-time incremental power market, and passes the full cost of this energy along to the wind operator. (More importantly, the wind operator’s failure to act on CAISO instructions after bidding in the real-time market may prevent future participation in this market.) During the second two 10-minute intervals, the wind operator’s bids are covered by the facility’s generation. During the final two 10-minute intervals, the wind operator overproduces by 5 MW, and CAISO must accept decremental energy bids from its decremental energy market. CAISO would then pass the revenues from the decrement sale along to the wind operator

Summary

The strategy and scenario outlined above is intended to provide an example of how a conservative wind operator might participate in California’s competitive energy markets. The strategy outlined above may not be ideal for wind resources, because it involves scheduling as much energy as is reliably possible into forward markets in order to reduce market risk. An alternate strategy would be for the wind operator to wait until bids for the real-time market are due, when wind generation forecasts are most accurate, and bid all of the wind generation into those short-term markets. Under this strategy the wind operator would run the risk of not having any demand for the facility’s supply. By the time the short-term or near-real time markets are in play, the CAISO may actually need to decrement power rather than increment it; if so, there will be no market for the incremental wind energy. Wind generators also could submit decrement bids to CAISO’s real-time imbalance market. In order to decrement, however, the wind generator would have had to schedule capacity ahead of time in a forward markets, agreeing to cut back on this commitment if instructed to do so in real-time by CAISO.