Information System to Better Integrate Wind and Solar Resources with Demand than Marginal Emissions Data

There is a growing need within the utility industry to describe electric power in consumer-friendly terms. As more energy comes from wind and solar, it becomes increasingly important for consumers to use energy when it is sunny and windy and use less energy when fossil-fuel power plants are ramping up and peaking each day. Showing when energy is cleaner along with pricing signals can achieve measurable reductions in peak demand as well as reductions in curtailment of renewable resources.

The majority of consumers surveyed by utilities want electric power from clean energy resources over energy from fossil fuels. An increasing number feel the need to do something about their impact on the environment, but most don't want to pay more. Many are buying technologies that enable them to control when they use energy, subscribing to services that directly provide them with cleaner energy, and switching to electric vehicles. Most consumers are not managing their load, and those that are don't use a tool to know when energy is cleaner.

In a separate but related issue, distributed energy storage systems participating in California's Self-Generation Incentive Program (SGIP) intended to better integrate renewables have actually increased greenhouse gas (GHG) emissions due to a misalignment of retail rates with solar energy production, and also as a result of on-site demand management being the principle operational criteria. California Public Utilities Commission (CPUC) staff has recommended adoption of a marginal emissions signal this year to remedy the misalignment, but a better approach would be to use forecasted energy demand, and forecasted production of wind and solar. This simpler approach can be predicted more accurately and reliably than hourly, daily, and seasonal emissions.

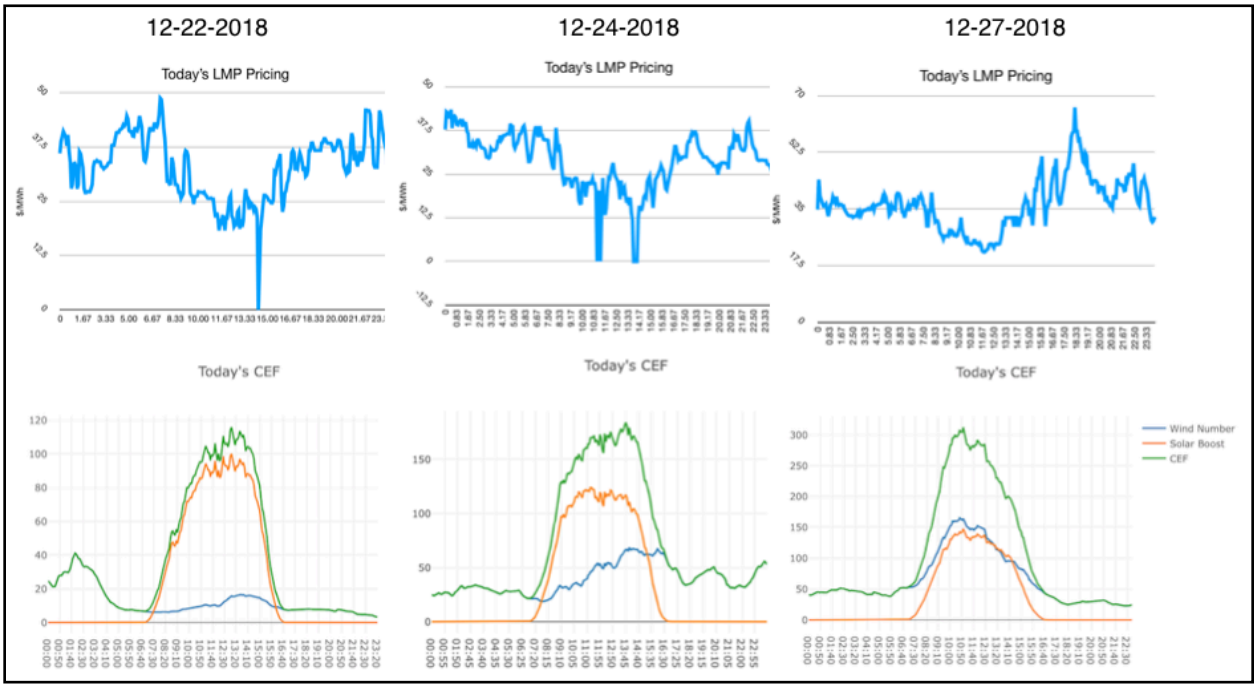
The best way for utilities to integrate time-variable renewables with consumer demand is to present electric power in terms of what people want; clean energy over power from fossil fuels. The Wind Number and Solar Boost describe energy as a Clean Energy Factor (CEF) that presents electric power in consumer-friendly terms as shown below;

Wind Number + Solar Boost = Clean Energy Factor (CEF)

$$\left(\frac{\text{Wind Power Resources}}{\text{Thermal Resources}} * 100\right) + \left(\frac{\text{Solar Power Resources}}{\text{Thermal Resources}} * C\right) = \text{Clean Energy Factor (CEF)}$$

Where:
Clean Energy Factor (CEF) is a Measure of Clean Energy Resources Relative to Power from Fossil Fuel Burning Plants
Wind Power Resources= Regional Wind Power Resources
Thermal Resources= Regional Natural Gas + Coal Power Resources
Solar Power Resources= Regional Solar Power Resources
C= Constant Based on Current Regional Solar Development Relative to Wind Development

Presenting systemwide energy data from the California Independent System Operator (CAISO) in this manner creates an opportunity to highlight when energy is cleaner as opposed to when carbon emissions and prices are higher. In fact, the CEF is inversely proportional to carbon emissions and wholesale prices, such that it illustrates that clean energy costs less to consumers and enables better management of automation. The CEF is presented as a real time application programming interface (API) and as a forecast API on the Sabreez website, www.sabreez.com.



The CEF has the following advantages over marginal emissions reporting;

1. The CEF is high when wholesale energy prices are low. If consumers find value in the message independent of rates, systemwide costs are reduced,
2. The CEF can be forecast more accurately than marginal carbon emissions and programmed into a robust API. The CEF thus enables automated switching of Distributed Energy Resources (DERs) consistent with the California SGIP GHG signal goals,
3. As utilities introduce pricing that may adversely impact at-risk groups, the CEF encourages automation while informing households that rely on manual control, benefiting all stakeholders.

Time of use rates are helpful to send value signals to energy consumers, but to be fully effective they should correlate with wholesale energy prices. Wholesale energy prices track the CEF inversely, making it a good candidate for rate design criteria. Similar to upward price spikes currently observed during peak hours, downward price spikes occur when the CEF is higher. The value of the clean energy message may be significant enough that consumers don't need a price reduction to act on the message. Moreover, if consumers are running their appliances or

charging their vehicle when energy is cleanest, they might not need to during peak hours each day when the CEF is lower.

Real-time pricing is often mentioned as the ultimate rate design, but as we replace our energy supply with fixed assets that cost little to operate and have inherently superior environmental benefits, we should spend significantly more effort and resources on informing people when and how to harvest cleaner electric power to complement the current adoption of time of use rates during peak periods. In this way, systemwide energy costs can be reduced while greatly increasing customer satisfaction for utilities and other energy system stakeholders.

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