ReadMe: Wholesale Electricity Prices (WEP) tool

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Suggested citation: Dev Millstein, Eric O'Shaughnessy, Ryan Wiser. 2026. Wholesale Electricity Prices (WEP) tool. Lawrence Berkeley National Laboratory. Version 2026.1
https://emp.lbl.gov/wholesale-electricity-prices-wep-tool

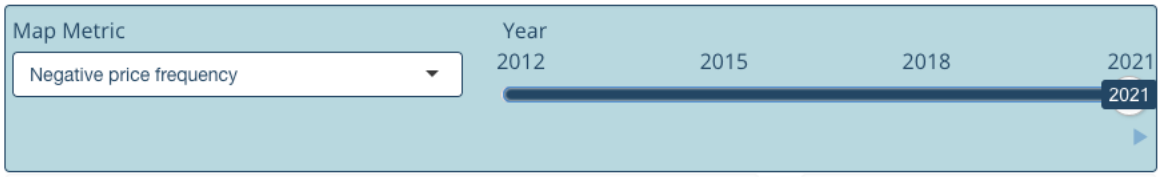
The Wholesale Electricity Prices (WEP) tool, allows users to explore trends in nodal wholesale energy pricing across the country and over time. Nodal wholesale energy pricing patterns can be complex, and those patterns are often obscured when looking at regional average annual pricing trends. The WEP tool allows users to compare pricing trends across locations, regions, and several different timeframes. These comparisons illustrate the ongoing interactions between generation resources, demand, and wholesale energy prices.

WEP consists of maps, time series, and other interactive figures that provide both: (1) a general overview of how average pricing, negative price frequency, and extreme high prices vary over time, and (2) a summary of how pricing patterns are related to generation and load. Interactive functionality allows investigation by independent system operator (ISO), year, season, and over diurnal cycles.

Functionality

WEP comprises two sets of interactive figures, one set of two figures (a map and a plot) for nodal clusters (see methodological notes below) and another set of seven plots for ISO-level figures. All figures are interactive in two ways: 1) the user can mouseover the plots to see the underlying values, and 2) the user can manipulate inputs based on two sets of filters.

The first filter controls the node cluster plots in the top row of the tool:

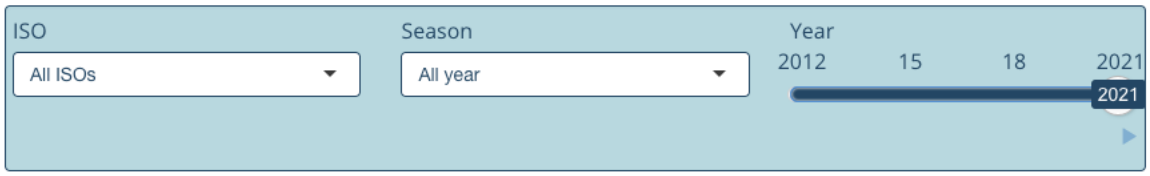


The **Map Metric** drop-down menu controls the output of the map on the left as well as the plot on the right. The tool allows the user to view these plots along three dimensions:

- *Average wholesale price*: Average wholesale price by node cluster and by year.
- *Negative price frequency*: The percentage of hours in a node cluster with negative pricing by year.
- *Mean price of 100 highest-priced hours*: We provide this metric to illustrate typical values of extreme prices.

The **Year** slider allows the user to toggle between different years. Note that the Year slider only affects the output in the map. The user can also click the play button in the bottom right of this filter bar to toggle through all years.

The second set of filters controls four more rows of figures based on ISO-level (or all-ISO) data:



The **ISO Data** drop-down allows the user to view data for All ISOs or for individual ISOs. The **Season** drop-down allows the user to view data for the entire year or for individual seasons. Finally, the **Year** slider allows the user to toggle between different years. Note that:

- The **Year** slider only affects output in the 365X24 average price figure, though the tool highlights the selected year as an orange line in three of the diurnal variation figures
- Note that the Median wholesale energy prices figure is based only on annual data only.

Downloads

The button under each plot allows the user to download a jpg file of the plot. At the very bottom of the tool is an option to download much of the data presented in the tool. If you have questions about additional data, please reach out to the listed contact.

Methodological Notes

Data

Prices come from hourly locational marginal price (LMP) data reported by each ISO and compiled through the commercial product "Velocity Suite." There are over 50,000 individual LMP nodes across the 7 major ISOs and associated energy imbalance markets. Total load and renewable energy generation data are reported by the ISOs, and in most cases compiled within the Velocity Suite. Generation and load within each ISO are included but generation and load are not included across the full energy imbalance regions (e.g., not including all of the Western Imbalance Market).

Real dollars

All reported prices are reported in real, not nominal dollars. Specifically, all dollars have been inflated to match the most recent year's dollar value. Dollars were inflated using the "Personal consumption expenditures" index within the Bureau of Economic Analysis's table of Implicit Price Deflators for Gross Domestic Product.

Geographic aggregation for mapping

The data in the map and figure in the first row are based on clusters of nodes. Each node cluster is defined as a grid cell with 30 km sides, and all nodes within the cell are included in the cluster. Values are first found for each node and then averaged across all nodes in each cluster. For example, the average of the top 100 priced hours is found for each node, and then averaged across all nodes in the cluster to provide the final value.

Negative pricing

Negative pricing is not necessarily, in and of itself, a problem in electricity markets. Negative prices simply provide additional incentive, compared to low but positive pricing, for generators to reduce output or batteries to charge. Wind and solar generators may prefer to generate during some negative-price hours in order to receive renewable energy credits or the production tax credit. Other types of generators may operate during negative pricing periods because of slow ramping speeds, the desire to provide ancillary services, the desire to avoid shutdown costs, or the desire to be fully operational during subsequent hours of higher pricing.

Average wholesale energy price

To calculate prices shown in the figures showing the average daily cycle of wholesale energy prices, the average wholesale prices under varying conditions, and the 365X24 heatmap of prices, the following approach was used. For each ISO, an hourly average price across all nodes in the ISO was calculated. To generate the 'All-ISO' figures, the weighted ISO-average prices were found using weights based on hourly load (that is, the average price in larger ISOs, as measured by MWh of load, is weighted more heavily than in smaller ISOs). A similar approach was used to calculate the fraction of negative prices across an ISO for the figure showing "Negative price frequency under varying conditions." In this case, for each hour, the fraction of an ISO's nodes containing a negative price was calculated.

Local daylight time

All times are in local daylight time. For aggregated statistics (e.g., when calculating demand peaks for the "under varying conditions" plots) an average value is calculated for the duplicated hours that occur around daylight savings time.

Median prices

For the figure that shows "Median wholesale energy prices (w/ 10/90th percentile) *Annual data only," median and 10^{th} and 90^{th} percentile was calculated as the median across nodes (i.e., we found the annual average price at each node, and then found the median value across all nodes in an ISO, or across all nodes in all seven ISOs in the 'All-ISO' case).

Storage option

In the ISO Data plots, there is an option to include storage for some years and some ISOs. When this option is checked the figure showing output from wind and utility-scale solar generators will now also include storage output (it will not include storage charging), The figure showing net load will now subtract storage output, in addition to wind and solar output, from total load. Note that storage charging is always included in the total load, whether the storage option is checked or not.