Short-Term Energy Outlook Retail Electricity Price Module

Concepts, Data Sources, and Techniques
Handbook of Energy Modeling Methods

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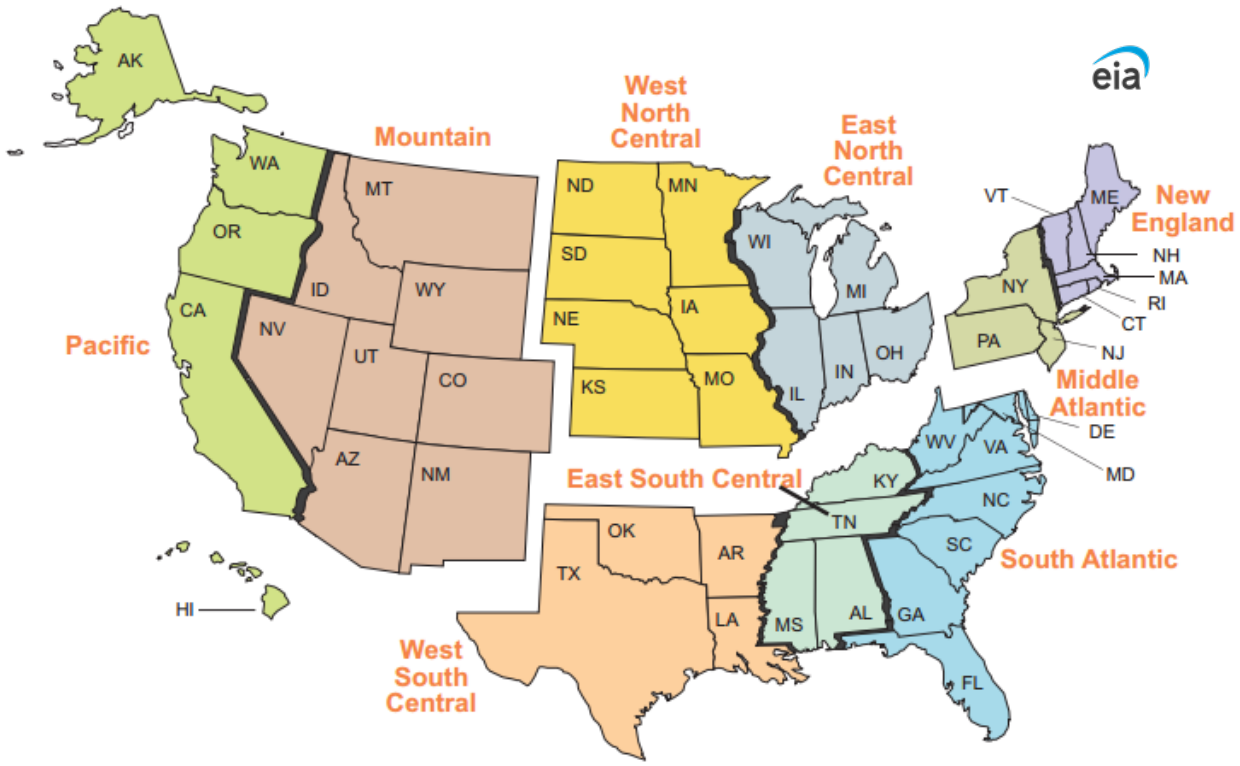
Introduction

The Retail Electricity Price Module is a component of the U.S. Short-Term Energy Model (USSTEM) within our Short-Term Integrated Forecasting System (STIFS). It provides forecasts of short-term, end-use (retail) electricity prices by region. The module tracks prices for four end-use sectors (residential, commercial, transportation, and industrial) for the United States and for the nine U.S. census divisions (Figure 1). The Retail Electricity Price Module is closely linked to the USSTEM Retail Electricity Sales Module.

Figure 1: U.S. census divisions



Data source: U.S. Census Bureau

Data Sources

The data input for the Retail Electricity Price Module is by month. The retail electricity price data that we publish is the average revenue per kilowatthour that utilities and electricity distributors receive in a given area over a certain period. In other words, it is the average electricity bill measured on a cents-per-kilowatthour basis. The primary data sources for retail electricity prices in the module are our:

- *Electric Power Monthly*
- *Electricity Monthly Update*
- *Electric Power Annual*

Retail electricity data in each of these publications are derived from three EIA surveys. Form EIA-861 collects operational data and characteristics annually from a sample of electric utilities and energy service providers. Schedule 4 of this survey collects information from respondents about the amount of electricity sold to retail customers and the corresponding amount of revenue received during the previous year.

Form EIA-861S is an abbreviated version of the EIA-861 that we send to approximately 1,100 smaller utilities. This survey collects data on total retail revenue and sales of electricity during the year, but it does not request a breakdown of how much they sell to each end-use sector. Once every five years, the respondents of this survey fill out the full Form EIA-861 instead of the abbreviated form.

Most investor-owned utilities and competitive retail electric suppliers (about 500 respondents) are required to file the Form EIA-861M survey each month. This survey collects retail revenues and sales to each end-use sector, and this observed data provide the basis for imputing the monthly sales and revenues of respondents who file the annual Forms EIA-861/861S.

The Retail Electricity Price Module also uses electricity sales data from the Form EIA-861/861-S and Form EIA-861M surveys. We use power generation fuel costs data from the Form EIA-923 survey for the exogenous variables in the module equations. We also include the wholesale electricity prices in the Retail Electricity Price Module. We obtain the historical wholesale price data from S&P Global, and our forecasts come from the USSTEM Electricity Supply Module.

Retail Electricity Price Module Inputs and Regression Models

In the Retail Electricity Price Module, regional retail electricity prices are estimated as a function of generation fuel costs, wholesale electricity prices, and other variables.

End-use sectors:

- Residential sector
- Commercial sector
- Industrial sector
- Transportation sector
- All end-use sectors

Census divisions for retail electricity (as shown in Figure 1):

- East North Central
- East South Central
- Pacific Noncontiguous
- Middle Atlantic
- Mountain
- New England
- Pacific Contiguous
- South Atlantic
- West North Central
- West South Central

The Retail Electricity Price Module differentiates between the contiguous Pacific states (California, Oregon, and Washington) and the noncontiguous Pacific states (Alaska and Hawaii).

Regional Retail Electricity Price Module Estimation

Electricity prices are the fees an electric utility company charges its customers for service. Electric utility companies charge their customers different rates based on the type of customer, the kind of contract, and the customer's electricity needs. An electric bill is computed based on the individual customer's rate, their consumption, and other charges, such as taxes and fuel adjustments. In states where the electricity industry is regulated, the list of different rates is called a tariff. The tariff provides the privately owned electric utility with enough income to cover operation and maintenance costs and to allow investors to earn a return on their investment.

Three major types of electric utilities deliver electricity to retail customers:

- Investor-owned utilities are owned by private stockholders and operate as regulated franchises, meaning that the prices they charge are subject to public review, often by a state public utility commission.
- Publicly owned electric utilities are nonprofit, local government agencies established to provide service to their communities and nearby consumers at cost, returning excess funds to the consumer as community contributions, more economic and efficient facilities, and lower rates. Publicly owned electric utilities (which number almost 1,000) include municipals, public power districts, federal or state authorities, irrigation districts, and other public organizations.
- Cooperative electric utilities are owned by and provide service exclusively to the cooperative members. Approximately 800 cooperative electric utilities are in the United States.

Electric utilities and distribution companies set rates for different classes of service. Residential rates are for service provided to individual households. The class of service for electricity sold to businesses is generally determined by the overall amount of power sold (that is, small, intermediate, or large). Rate schedules within a tariff generally don't differentiate by the type of business. Industrial facilities are often utilities' largest customers and usually receive the lowest rates, especially when they can connect their facilities directly to the transmission grid without reducing voltage.

Some utilities break down the electricity charges shown on customer bills into various components, reflecting the costs of generating, transmitting, and distributing the electricity. We calculate average retail prices of electricity by dividing utility revenue by retail sales. The resulting measurement is the price, or average revenue per kilowatthour, of electricity sold.

Some states have deregulated their electricity industry, and retail customers can choose a retail power marketer to supply the electricity they consume. Customers' electricity bills in deregulated states generally are broken down into two types of charges: charges for the energy provided by the power marketer and charges for delivering the electricity, which in most cases is still provided by a regulated utility.

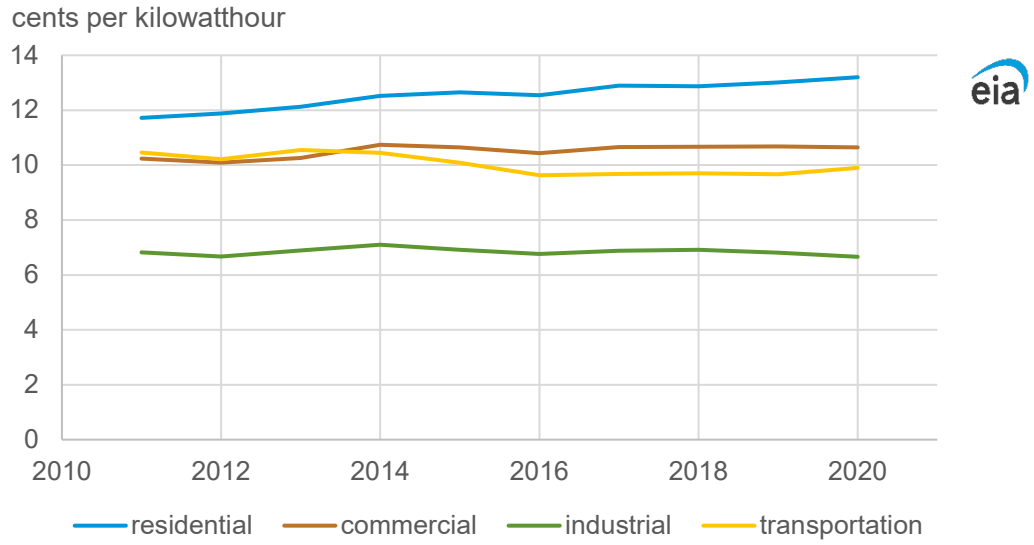
Retail prices vary significantly from state to state. The regional prices reflect the mix of energy sources used by regional generating units, the cost of fuels, and transmission and distribution costs. Retail customers in the Northeast and Hawaii have historically paid the most for electricity. Many utilities in New England have had trouble getting generation fuels in recent years. Costs in the Northwest are lower

due to the wide availability of hydroelectric facilities. Most state regulatory commissions allow fuel cost adjustments in retail rates to allow the utilities to pass through changes in generation fuel costs. In deregulated states, changes in costs often pass through more quickly to retail customers.

The regional price differences have been one of the primary catalysts driving the restructuring of the electricity industry. States that have historically had the highest retail prices have been among the first to experiment with restructuring. Some deregulated states have allowed the industry to join markets for wholesale electricity in which generators, utilities and power marketers buy and sell electricity from each other. In addition, some states have deregulated the retail side of the industry so that customers have a choice of which firm generates the electricity they consume. The goal of both restructuring strategies is to lower retail electricity prices.

The average price per kilowatthour for residential consumers is generally higher than for any other end-use sector due, in part, to higher costs associated with serving many consumers who use relatively small amounts of electricity (Figure 2). Many industrial customers have arranged for time-of-use pricing or interruptible service agreements that allow them to shift their electricity consumption to periods of the day when electricity costs less to generate.

Figure 2: The U.S. average retail price of electricity to ultimate customers, 2011–2020



Data Source: U.S. Energy Information Administration

We designed the USSTEM Retail Electricity Price Module to forecast electricity prices for each end-use sector within the nine census divisions.[1] The module estimates retail prices in each regional area individually and then aggregates them into a national average for each end-use sector and a national average across all end-use sectors. The module equations estimate the year-over-year growth in each sector's retail electricity price. We calculate the forecast retail prices from these estimated growth rates.

[1] The Retail Electricity Price Module divides the Pacific Census Division into two separate areas: California, Oregon, and Washington and Hawaii and Alaska.

Residential sector retail price estimation

Wholesale electricity prices are the most important explanatory variable determining retail prices. They reflect the cost of generating electricity, including fuel costs, such as for coal and natural gas.

Besides fuel costs, utilities have to recoup the costs of building and maintaining generation, transmission, and other facilities. These costs are generally fixed, but the total amount of electricity sold can affect how these fixed costs are reflected in average retail rates. Each equations' constant term and the trend underlying the dynamic equation specification account for these fixed cost components of retail prices. The explanatory variables in residential retail price equations for each census division include:

- Total sales of electricity to the residential sector, billion kilowatthours per day
- Wholesale electricity prices in associated electricity supply region, dollars per megawatthour
- Dummy variables included to account for extreme outlier observations
- Lagged retail residential price to account for autocorrelation

The wholesale price variables are set up in the equation using a polynomial distributed lag structure to account for the varying amounts of time between when costs are incurred and the time they are eventually passed through to retail electricity rates.

Commercial sector retail price estimation

Commercial customers purchase electricity from utilities under non-residential rate schedules for electricity tariffs. These rate schedules are often categorized by the general range of typical power usage. Commercial customers are usually categorized within the small to medium usage non-residential categories. Because these customers generally consume more power than residential customers, their overall rates are generally lower. The explanatory variables in retail electricity price equations for the commercial sector for each census division include:

- Total retail sales of electricity to the commercial sector, billion kilowatthours per day
- Wholesale electricity prices in associated electricity supply region, dollars per megawatthour
- Dummy variables to account for extreme outlier observations
- Lagged retail commercial price to account for autocorrelation

The wholesale price variables are set up in the equation using a polynomial distributed lag structure to account for the varying amounts of time between when costs are incurred and the time they are eventually passed through to retail electricity rates.

Industrial sector retail price estimation

Electricity prices in the industrial sector are generally more variable than in the residential or commercial sectors. Many manufacturing facilities can generate their own electric power, which they can use to supplement or substitute for retail electricity purchases if the cost of self-generation is low compared with the retail price of electricity. The explanatory variables in industrial retail electricity price equations for each census division include:

- Total retail sales of electricity to the industrial sector, billion kilowatthours per day

- Wholesale electricity prices in associated electricity supply region, dollars per megawatthour
- Dummy variables to account for extreme outlier observations
- Lagged retail industrial price to account for autocorrelation

The wholesale price variables are set up in the equation using a polynomial distributed lag structure to account for the varying amounts of time between when costs are incurred and the time they are eventually passed through to retail electricity rates.

Transportation sector retail price estimation

Retail sales of electricity to the transportation sector consist primarily of sales to public transit operators such as subway, light-rail, and streetcar systems. The overall transportation-sector electricity sales are very small compared with the amount sold to other end-use sectors, and the number of customers is also much smaller. Transportation sales can be quite variable, so forecasting transportation sales and revenues can be difficult. The explanatory variables in the retail electricity price equations for the transportation sector for each census division include:

- Retail transportation electricity price, cents per kilowatthour
- Total retail sales of electricity to the transportation sector, billion kilowatthours per day
- Dummy variables to account for extreme outlier observations
- Lagged transportation sector electricity price to account for autocorrelation

Average retail price across all end-use sector estimations

The average retail price of electricity sold across all end-use sectors is equal to the weighted average of the estimated prices for the four end-use sectors, where the weights are the retail electricity sales to each end-use sector (all units below are in billion kilowatthours per day):

- Total retail sales of electricity to all end-use sectors in a census division.
- Retail sales of electricity to the residential sector in a census division.
- Retail sales of electricity to the commercial sector in a census division.
- Retail sales of electricity to the industrial sector in a census division.
- Retail sales of electricity to the transportation sector in a census division.

Model adjustment factors

Most regression models in the STIFS Retail Electricity Price Module have associated add factors, which allow manual adjustments to the modeled output. The add factors allow additive adjustments to the forecasts of the regression model's dependent variable to reflect analyst judgment about issues that might not be adequately reflected in the model's independent variables, such as extended power outages and extreme weather events.