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National Utility Rate Database

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S. Ong and R. McKeel

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WREF 2012: NATIONAL UTILITY RATE DATABASE

Sean Ong, Ryan McKeel
National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, CO 80401
Sean.Ong@nrel.gov
Ryan.McKeel@nrel.gov

ABSTRACT

When modeling solar energy technologies and other distributed energy systems, using high-quality expansive electricity rates is essential. The National Renewable Energy Laboratory (NREL) developed a utility rate platform for entering, storing, updating, and accessing a large collection of utility rates from around the United States. This utility rate platform lives on the Open Energy Information (OpenEI) website, OpenEI.org, allowing the data to be programmatically accessed from a web browser, using an application programming interface (API). The semantic-based utility rate platform currently has record of 1,885 utility rates and covers over 85% of the electricity consumption in the United States.

1. INTRODUCTION

Access to detailed utility rate data is important for a variety of energy-related analyses efforts. The retail price of electricity is the single most important factor affecting the economics of residential photovoltaic (PV) systems (Denholm et al. 2009). Electricity prices are also important for economic calculations of other distributed generation technologies, building energy management solutions, and electric vehicle charging.

Until the introduction of the National Utility Rate Database, there was no publicly available utility rate database (EIA 2012a). Analyses that required electricity rate information typically used averaged or blended rates, which are derived from utilities' revenue and sales data (EIA 2012c). Table 1 shows an example of average residential rates, as reported by the Energy Information Administration (EIA). Any of these rates could be used for Colorado; however, the best choice would be the one with the most specific location, the Xcel Energy, the electric utility for Denver, Colorado.

The average residential rate for Denver shown in Table 1 was derived from Xcel Energy's total revenue and sales in Colorado. This is referred to as a blended rate, as it blends all charges—fixed and variable—into a single number. Although blended rates may be at a sufficient resolution for high-level analysis, it is important to have actual rate structure data when performing a detailed analysis in order obtain accurate results. Various types of utility rates are used throughout the United States, including: flat rates, seasonally varying rates, time-of-use rates, demand charges, and tiered or block rates (these are described in more detail in Section 3).

TABLE 1: TYPICAL ELECTRICITY RATE VALUES THAT ARE USED FOR DENVER, CO

Location	Average Residential Rate in 2010 (cents/kWh)
United States	11.5
Mountain Region	10.5
State of Colorado	11.0
Denver, CO (Xcel Energy[1])	11.2

Source: EIA dataset EIA-861

[1]Within the State of Colorado, Xcel Energy legally operates as the Public Service Company of Colorado.

The various rate structure types can significantly impact the economics of distributed energy systems, such as solar installations (Ong et al. 2010). Rate structure data is needed in order to make informed decisions regarding home and building energy management[2]. Prior to the existence of the National Utility Rate Database, energy analysts that needed detailed utility rate structure data had to collect this data from individual electric utilities. Collecting this data has required trained individuals to look through utility tariff books, which typically comprise several hundred pages. These efforts were repeated across organizations, and this data could not be shared easily between organizations due to the lack of a common standard or database.

NREL developed the National Utility Rate Database in 2010 as a free, web-based tool in which the energy analysis community could contribute, edit, and download utility rate data. This database was developed on the OpenEI.org platform, where it continues to provide high-fidelity rate data and web services for integration with other applications. As of 2012, Illinois State University (ISU) was selected by the U.S. Department of Energy's SunShot program to populate, maintain, and improve the database.

2. OPENEI PLATFORM

The OpenEI organization is a knowledge sharing online community dedicated to connecting people with the latest information and data on energy resources from around the world. OpenEI provides access to energy-related information via geographic discovery, unique visualizations, and topic-oriented gateways (OpenEI A). OpenEI is built on the MediaWiki and Drupal platforms and is open to the public to add and edit both content and data.

The OpenEI wiki holds over 56,000 pages (OpenEI B) which store narrative content and structured data. All structured data on OpenEI is available via web services using the semantic MediaWiki built-in query language (OpenEI C). The OpenEI datasets section has data and references for over 800 energy datasets. In contrast to governmental websites such as Data.gov, OpenEI hosts datasets from any source around the world, and is not limited to datasets from government agencies.

OpenEI's underlying emphasis on structured data and web services forms the basis for direct consumer access to energy data through the OpenEI website and through applications built on OpenEI. Sample questions that OpenEI can answer programmatically include:

- *"How many utility companies are located in the United States?"*
- *"What is the solar potential for India in megawatt hours per year?"*
- *"What financial incentives are available to Texas homeowners looking to purchase energy efficient appliances?"*
- *"What is a fuel cell?"*
- *"What energy organizations exist in the San Francisco Bay area?"*

Crowd-sourcing is a core operating philosophy of OpenEI. The *Merriam Webster* dictionary defines crowd sourcing as "the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers." (*Merriam Webster*)

More than 3,000 visitors to OpenEI have created an account, performing community functions like editing and creating pages. To seed structural data on OpenEI, bots[3] are used to populate pages and linkages between concepts. To avoid re-creating content that is available elsewhere, OpenEI directly extracts content from other semantically-enabled websites. For instance, the "India Energy Resources" page on OpenEI pulls data from a growing repository of energy maps related to India and the websites Wikipedia.org and REEGLE.info (OpenEI D). This enables visitors to browse organized information about energy topics from around the web without concern about accessing out of date or duplicate data.

Generating and maintaining an accurate database of electric utility rates is a difficult problem to solve. There is no central repository for utility rate data (EIA 2012a), and

[2] For example, in places that use time-of-use (TOU) rates, it is more cost effective to run a dishwasher or dryer at night than it is during the day. It is also more cost effective to charge electric vehicles during hours when electricity prices are low.

[3] A bot is an automated process that performs specific tasks.

data collection efforts are further complicated due to periodic changes to rate structures. With no centralized reporting mechanism or structure, this data often resides in a non-machine readable document format. A desire for accurate, structured utility rate data lends itself to an input mechanism that harnesses crowd sourcing.

Users of utility rate data may wonder, *"How can this database be open to the public for creation and editing, yet maintain a high-level of data quality?"* In the case of the National Utility Rate Database, subject matter experts are the data wardens. When a new entry is created, a subject matter expert receives an email or notification by RSS feed, suggesting a review. Data that has been verified by a subject matter expert indicates an "approved" status. Data that have not been verified will still be accessible to the public, but is labeled as "not yet approved."

In 2010, energy analysts at NREL identified the utility rate data on OpenEI as a high-value digital asset. The OpenEI developers integrated the database into a web service for use by external applications. The National Renewable Energy Laboratory's System Advisor Model (SAM) was the first application to utilize this web service, and added capabilities to download data directly from the National Utility Rate Database. As of this writing. several other organizations are reviewing the feasibility of using this web service to programmatically access the National Utility Rate Database.

3. TYPES OF ELECTRIC UTILITY RATES

Various types of utility rates are used throughout the United States. The most common rate types (Ong et al. 2011) include the following:

- Flat rates. Fixed cost of energy that does not vary except for fuel cost adjustments and other fees.
- Seasonal rates. Rates vary by season. A typical seasonal rate structure has a lower rate for winter months and a higher rate for summer months.
- Time-of-use rates. Time-of-use (TOU) or time-of-day rate structures usually vary 2–4 times a day. A typical TOU rate has a lower cost at night, a higher cost during the late afternoon, and an intermediate cost during the mornings and evenings. The term "onpeak" or "peak" is generally used to describe hours with higher prices while "off-peak" is used to describe hours with lower prices.
- Demand charges. Normally included with energy charges in applicable rate structures, demand charges charge customers for their peak power (kilowatts) usage. Demand charges can also be fixed or vary by season or hour.
- Tiered or block rates. Tiered rates typically refer to rates that increase with increasing electricity usage while block rates typically refer to rates that decrease with increasing electricity usage. These rates are most common in the form of energy charges; however, tiered demand charges are also used.
- Database Statistics

This section describes the status of the National Utility Rate Database as of March 13, 2012.

Through crowdsourcing and data seeding techniques, over 500 utility rates were added to the National Utility Rate Database from the time of its launch in 2010, until the end of 2011. From January 1st, 2012 to March 13th, 2012, over 1,300 new utility rates were added, largely ISU in response to their SunShot award from the Department of Energy (DOE 2012). In total, the database contains data for 1,885 utility rates.

TABLE 2: ELECTRIC RATE STRUCTURE TYPES SUPPORTED IN THE DATABASE.

Rate Structure Type	Supported in Utility Rate Database
Flat Rates	Yes
Seasonally Varying Rates	Yes
Time-of-Use (TOU) Rates	Yes
Tiered / Block Rates	Yes
Tiered TOU Rates	No (planned 2013)
Tiered Demand Charges	No (planned 2013)
Reactive Power (kVAR) Charges	No

The 1,885 rates in the database represent 430 utility companies. There are over 3,300 utilities in the United States, but only a subset of these serve the majority of the

nation's electricity load (EIA 2012c). Initial data collection efforts focused primarily on the largest utilities, so the National Utility Rate Database contains data that cover 85% of all electricity served in the United States. Figure 1 illustrates the current coverage of utilities within the Utility Rate Database. Of the 430 utilities in the database, 40% have one or two rate entries, 38% have between three and six rate entries, and 22% have more than six entries.

OpenEI synchronizes its database of utility company names with the EIA's Form EIA-861 data (EIA 2012c). Utility rate data on OpenEI can be queried by the name of the utility company or the EIA utility identification number, which is a unique identifier for each utility company. Utility companies and their rates can also be searched for by zip code. Additionally, a universally unique identifier (UUID) is automatically assigned to each utility rate to ease scalability and eliminate issues with community-generated titles for utility rates. Thus, a utility rate is identified by a UUID instead of the typical page title as a unique identifier. Sample queries and documentation for OpenEI utility rate data are located at http://en.openei.org/services/.

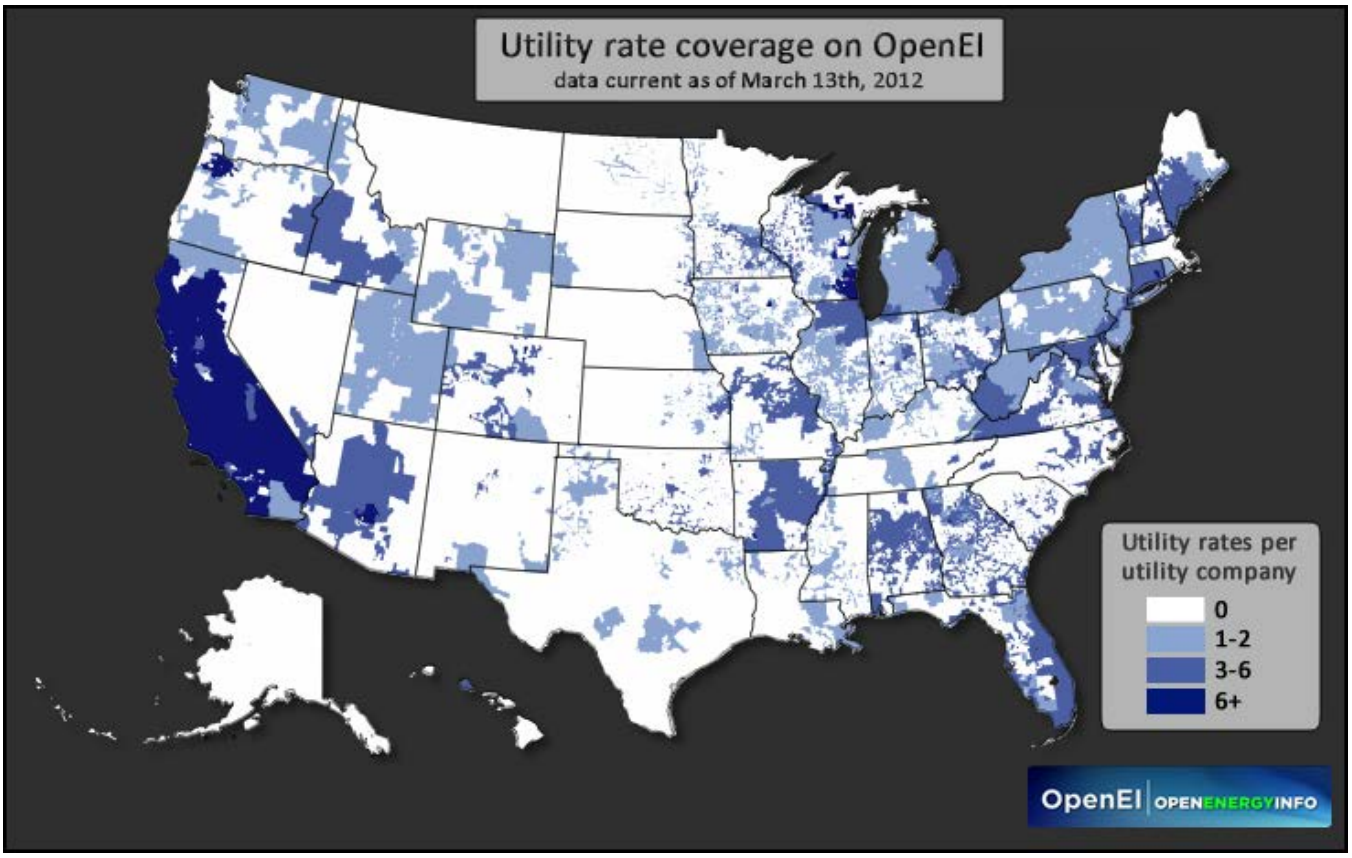

Fig. 1: This map shows utility rates entered into OpenEI as of March 13, 2012.

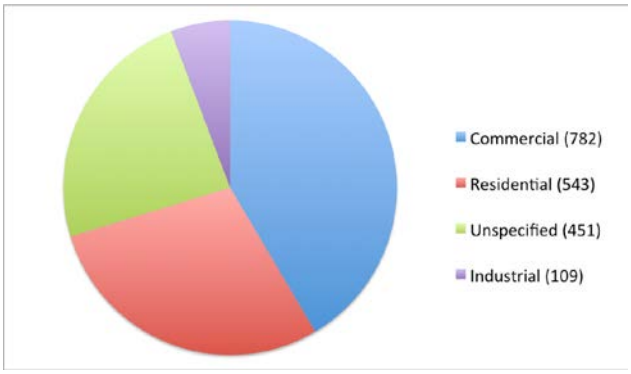

Fig. 2: Contributed utility rates by end-use sector.

The rates are categorized both by end-use sector and by rate structure type. Figure 2 illustrates the portion of utility rates in each sector. Some utility rate entries do not specify a sector, which likely indicates that the rate entry is incomplete and pending further subject matter review.

Figures 3a and 3b illustrate the breakdown of rate structure type by residential and commercial sectors. Tiered rates are the most common structure for residential rates, while rate types are more evenly distributed in the commercial sector.

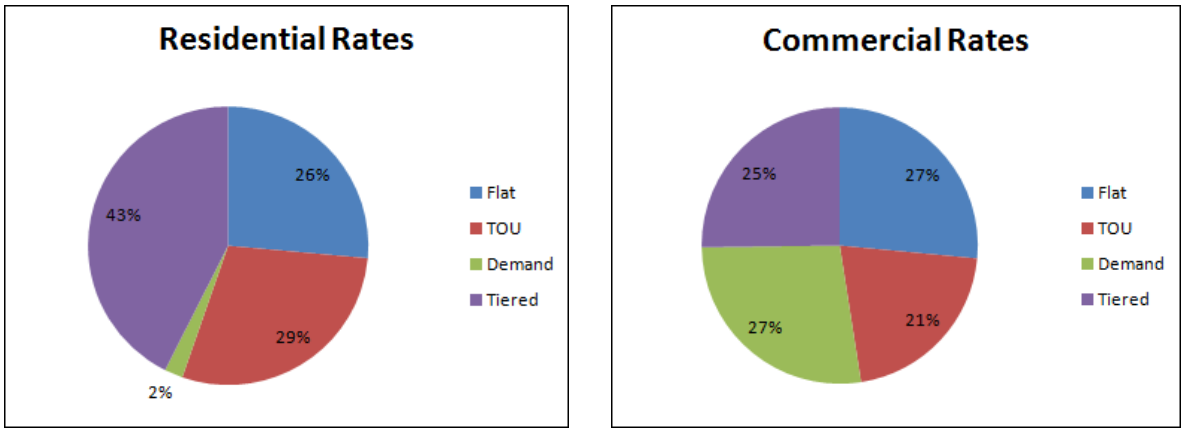

Fig. 3: Rate structure types by residential and commercial sectors.

4. DATABASE USAGE AND FUTURE EFFORTS

Since its release, the Utility Rate Database has been instrumental in a variety of analyses efforts. A recent project, funded by the DOE Solar America Showcase program (DOE 2012b), explored the economics of rooftop PV system on schools in California (Ong, et al. 2011). The database was a crucial component to the analysis; the analysis focused on the impacts of choosing optimal rate structures. Results from the analysis (see Fig. 4) showed that system economics were highly sensitive to the rate structures and provided insights on how optimal rate types can be identified.

A variety of other analyses efforts that rely on the database are currently in progress at NREL. These include projects that evaluate the impact of utility rates on various building types throughout the United States and projects that explore the grid-parity of solar PV in the United States.

With the SunShot award, ISU will be improving the Utility Rate Database by adding additional capabilities that will allow it to be compatible with a wider variety of rate structure types. ISU will also populate and maintain the database, with a goal of 100% coverage of U.S. rates within the next three years. ISU will leverage expertise from within its Institute for Regulatory Policy Studies to provide long-term solutions for maintaining the data.

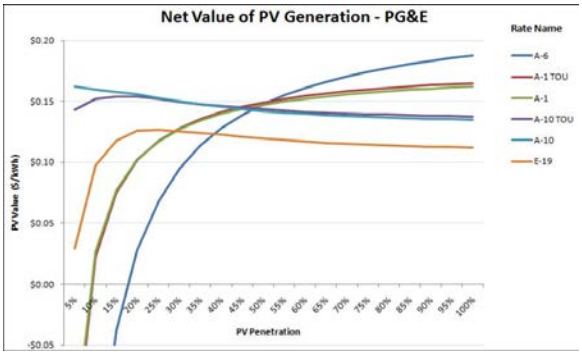

Fig. 4: Results from an analysis of PV systems on school rooftops show that rates significantly impact system economics.

5. CONCLUSION

When modeling solar energy technologies and other distributed energy systems, using applicable electricity rates is essential to accurately assess system economics. In response to the need for high-quality expansive utility rate data, a utility rate platform was developed for entering, storing, updating, and accessing a large collection of utility rates from around the United States. Since its debut in 2010, the Utility Rate Database has been utilized in several analyses efforts. It has been integrated into external applications, where rates are able to be downloaded for use in computer models and tools.

The National Utility Rate Database currently contains data for utility companies that serve 85% of all electricity in the United States. Through efforts from ISU, NREL, and the United States Department of Energy, improvements and development of the Utility Rate Database continue, with a goal of 100% U.S. coverage within three years.

6. REFERENCES

OpenEI A. (2012). “Energy Information, Data, and other Resources | OpenEI.” Open Energy Information (OpenEI). http://en.openei.org/. Accessed March 13, 2012.

OpenEI B). (2012). “Statistics | Open Energy Information.” OpenEI. http://en.openei.org/wiki/Special:Statistics. Accessed March 13, 2012.

OpenEI C. (2012). “Semantic search | Open Energy Information.” OpenEI. http://en.openei.org/wiki/Special:Ask. Accessed March 8, 2012.

OpenEI D. (2012). “India: Energy Resources | Open Energy Information.” OpenEI. http://en.openei.org/wiki/India. Accessed March 13, 2012.

Merriam Webster. (2012). “Crowdsourcing - Definition and More from the *Free Merriam-Webster Dictionary*.” http://www.merriam-webster.com/dictionary/crowdsourcing. Accessed March 8, 2012.

EIA A. (2012). “Does EIA publish electric utility rate, tariff, and demand charge data? - FAQ - U.S. Energy Information Administration (EIA).” www.eia.gov/tools/faqs/faq.cfm?id=20&t=3. Accessed March 8, 2012.

EIA B: Energy Information Administration (EIA). (2012). "Electric Power Industry--Utility Contacts." EIA. http://www.eia.gov/cneaf/electricity/utility/utiltabs.html. Accessed March 8, 2012.

EIA C: (2012). "Annual Electric Utility Data - EIA-861 Data File." EIA. http://205.254.135.24/cneaf/electricity/page/eia861.html. Accessed March 8, 2012.

DOE A (2012). "SunShot Initiative: Solar Projects to Reduce Non-Hardware Balance of System Costs." U.S. Department of Energy (DOE). www1.eere.energy.gov/solar/sunshot/nonhardware_bos.html. Accessed March 8, 2012.

DOE B (2012). "2009 Solar America Showcases." U.S. Department of Energy (DOE). http://www1.eere.energy.gov/solar/2009_showcases.html. Accessed March 21, 2012.

SAM (2012). "System Advisor Model (SAM)." National Renewable Energy Laboratory (NREL). https://sam.nrel.gov/. Accessed March 8, 2012.

Denholm, P.; Margolis, R.M.; Ong, S.; Roberts, B. (2009). *Break-Even Cost for Residential Photovoltaics in the United States: Key Drivers and Sensitivities*. NREL. NREL/TP-6A2-46909. Golden, CO.

Ong, S.; Denholm, P. (2011). *Maximizing the Value of Photovoltaic Installation on Schools in California: Choosing the Best Electricity Rates*. NREL. NREL/TP-6A20-51694. Golden, CO.

Ong, S.; Denholm, P.; Doris, E. (2010). *The Impacts of Commercial Electric Utility Rate Structure Elements on the Economics of Photovoltaic Systems* . NREL. NREL/TP-6A2-46782. Golden, CO.