PURPA Standard: Smart Grid Investments

Columbia Water & Light position paper

2007 PURPA STANDARD

Section 1307 of the Energy Independence and Security Act of 2007 amends , PURPA 111 (d) (16 and 17) by adding a new standard that requires consideration of "Consideration of Smart Grid Investments" The statute states:

(17) SMART GRID INFORMATION-
(A) STANDARD- All electricity purchasers shall be provided direct access, in written or electronic machine-readable form as appropriate, to information from their electricity provider as provided in subparagraph (B).
(B) INFORMATION- Information provided under this section, to the extent practicable, shall include:
(i) PRICES- Purchasers and other interested persons shall be provided with information on—
(I) time-based electricity prices in the wholesale electricity market; and
(II) time-based electricity retail prices or rates that are available to the purchasers.
(ii) USAGE- Purchasers shall be provided with the number of electricity units, expressed in kwh, purchased by them.
(iii) INTERVALS AND PROJECTIONS- Updates of information on prices and usage shall be offered on not less than a daily basis, shall include hourly price and use information, where available, and shall include a dayahead projection of such price information to the extent available.
(iv) SOURCES- Purchasers and other interested persons shall be provided annually with written information on the sources of the power provided by the utility, to the extent it can be determined, by type of generation, including
greenhouse gas emissions associated with each type of generation, for intervals during which such information is available on a cost-effective basis.
(C) ACCESS- Purchasers shall be able to access their own information at any time through the Internet and on other means of communication elected by that utility for Smart Grid applications. Other interested persons shall be able to access information not specific to any purchaser through the Internet. Information specific to any purchaser shall be provided solely to that purchaser.

The Energy Independence and Security Act of 2007 also contained a statement of support for a national policy for the development of a smart grid intended to modernize the electricity transmission and distribution system. Section 1301 of the statute states:

It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve
each of the following, which together characterize a Smart Grid:
(1) Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.
(2) Dynamic optimization of grid operations and resources, with full cyber-security.
(3) Deployment and integration of distributed resources and generation, including renewable resources.
(4) Development and incorporation of demand response, demand-side resources, and energy efficiency resources.

(5) Deployment of ‘‘smart’’ technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.
(6) Integration of ‘‘smart’’ appliances and consumer devices.
(7) Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.
(8) Provision to consumers of timely information and control options.
(9) Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
(10) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Note: Due to the new statutes containing many of the same requirements, this utility position paper will be organized according to the different components of a smart grid.

DEFINTION OF SMART GRID

Currently, there is no statute or law that defines what constitutes a smart grid. The term generally refers to an electric distribution system that can provide detailed tracking of energy use. This data is supplied to both the utility and the customer for more efficient use of power resources. Utilities across the United States already have some of the functional aspects of the smart grid in place. Columbia Water & Light uses a SCADA computer system to control the transfer of power in the transmission and distribution system. Customers’ electric meter data is digitally transferred to the billing system and the billing history can be reviewed by the customer through different methods. The difference between the current system and the newly proposed smart grid is the amount of data gathered and how the utility and the customer receive and use that data.

MAIN COMPONENTS OF A SMART GRID

Meter: This device records electric usage data.

Data: Can include but is not limited to the utility’s Energy Management System, customer usage data, energy sources and costs of power

Telecommunications Network: Needed to transfer data between the meter, the utility and the customer.

Cyber Security and Privacy: Data transfer security within the utility and from the utility to the customer along with who has access to the information.

Control Energy Resources: The utility’s Energy Management System can control extra generation units according to when they are needed and the cost of electricity.

Time Based Rates: Incentives are given to customers that shift electric loads from peak pricing times to times when energy is less expensive.

Control of Electric Load: Using automatic controls to gain efficiencies when electric prices are higher. Columbia Water & Light operates a load control program to reduce peak electric costs.

Metering

Columbia Water & Light has an automatic meter reading (AMR) system that uses Encoder Receiver Transmitter (ERT) meters. Approximately once a month, a meter reader collects data from a handheld, mobile or fixed network device. These types of meters installed in the residential sector and most of the small commercial locations for under $50 each. For customers that have electric peak loads greater than 500 kilowatts in a month, an MV90 meter is used. The meter records energy usage and the electric demand component. This system provides electric usage data every 15 minutes and the customer can access the data by contacting the utility for a report.

In discussions of a smart grid, the metering system description changes to an automated meter infrastructure (AMI). This refers to a metering system that collects data more often and can transmit it to the data collection equipment where it can be downloaded when needed. The cost of these meters is $350 to $500 each. These meters would collect electric usage information every hour. There are over 44,000 residential and small commercial customers so the total replacement cost would be around $19 million. If the meters were phased in over time, the old and the new meters could be used within the same system if the same vendor was used. The new meters are “backwards compatible” with the old ones.

There are a few devices that could be provided to the customers to view their electric consumption with their current meter. The information from the meter can be transferred to a ‘dashboard’ device or to a personal computer. A dashboard device is a small unit with a screen that displays electric consumption data. The cost of these devices range from $200 to $350.

Data

Electric usage data is the backbone of the smart grid system. The utility could use data collected at shorter intervals for cost of service analysis, forecasting, theft detection, distribution system planning and showing results of demand side management programs. The word ‘data’ in the case of smart metering systems could also refer to existing data transfers which might or might not need to be updated. This includes production amounts from renewable distributed generation resources and the Midwest Independent System Operator on electric prices at a given time.

Energy Management System

Columbia Water & Light uses a supervisory control and data acquisition system (SCADA) to monitor and control the electric transmission and distribution system. The computer system is not connected to the city's main network and falls under strict security guidelines from the federal government. The system controls the stream of power into the system, how it flows through the transmission lines, substations and distribution lines. It is used with the outage management system to track problems and helps with repairs. This system would need to be upgraded to integrate the new measures suggested in the latest PURPA standards. It is difficult to get an exact bid from a vendor without knowing the structure of Columbia's smart grid but a general estimate to upgrade the SCADA system would be $3 million.

Telecommunications Network

To establish a smart grid system, customer data would have to be collected, stored and transmitted from the automated meter infrastructure. This information would need to be available to both the utility and the customer. A wireless mesh network could be established. By using a wireless system, the city would avoid the cost of disturbing property to add either overhead or underground cabling. The cost of one node of a wireless network for the automated meter infrastructure is $8,500. Columbia Water & Light's territory is approximately 61 square miles which would require 1,094 nodes. The cost to cover the city with a wireless network would be approximately $9.3 million.

For a fully integrated smart grid system, the utility would need software that would enable customers to access their current meter data, costs, electric consumption history and eventually have customers remotely control their heating and cooling systems and appliances. At this time, a cost estimate is hard to quote since so many other pieces of the puzzle need to be put in place first.

Cyber Security and Privacy

The electric industry is heavily regulated by the federal government so the reliability of the system is not compromised. Any metering system, data collection device, telecommunications network and computer software would have to be evaluated by the city's staff to guarantee utility and customer data could not be monitored or hacked into by an outsider. New technology implemented in the electric system would also have to adhere to federal laws.

Columbia Water & Light is a municipally owned utility that falls under the State of Missouri sunshine laws. Certain information about critical infrastructure processes is not required to be released under the law. However, any customer contact information, billing history and energy consumption has to be made public when requested. Utility billing data could become very valuable as the electric market is transformed. The Columbia City Council would need to keep the sunshine law requirements in mind as more usage data is collected from customers.

Control Energy Resources
Much of the Energy Independence and Security Act of 2007 deals with utilities using different resources to supply electricity to customers. The current SCADA system controls distributed generation systems within the Columbia service territory.

Distributed generation units can supply back-up power to a customer. The utility can run these units if there is a power deficit in Columbia or the cost of running the units is lower than other resources. The electric industry is moving to more distributed generation projects because of their potential efficiencies, especially with Combined Heat and Power units. These units are being evaluated by the utility because they could provide power for larger customers and the waste heat from the units could also be used by an industry.

Renewable energy projects, like solar photovoltaic panels, are becoming more popular with customers. Solar energy is a better resource in Columbia than wind due to the low wind speeds in the city. Solar energy is also a good resource in the summer when electric consumption is high. Although the cost of solar panels is still high, it is expected that they will become a more affordable option for Columbia customers in the future. A net metering arrangement helps the utility track these resources.

Controlling Columbia's electric load through efficiencies was started by the utility in 1984 with the Load Management program. Remote controlled devices on air conditioners help the utility rotate high demand during peak conditions. The Load Shedding program was started in 1994 for customers with larger electric loads. The customers are given an incentive for shedding load during peak conditions. These customers have MV90 so data can be monitored closely on reductions in energy use.

Time Based Rates
Current Rate Incentives for Demand Response
In Columbia, there is not a huge variation in the utility's electric supply costs because the majority of Columbia's energy requirements are met through established contracts. The price of energy does go up for the utility during peak summer load so Columbia Water & Light has rates structured to reflect this.

1. For Industrial and Large General Service customers, energy and demand pricing are higher during the summer season than the non-summer season. Small General (commercial) customers are subject to higher summer rates when usage exceeds 1,500 kilowatt hours in one month. For residential customers, higher rates occur in the summer months when usage exceeds 750 kilowatt hours and again when usage exceeds 2,000 kilowatt hours in a one month period.

2. Credits for consumers who participate in pre-established peak load reduction agreements can reduce the utility's planned capacity obligations. The three credit programs offered by Columbia Water & Light are:
    a. Load Management Discount: This program provides a three percent discount on summer bills for customers that allow the installation of a load control switch on their air conditioner. Over 16,000 customers participate in this program. It is estimated that eight megawatts of peak load can be avoided with this program.
    b. Load Shedding Program: Larger customers (those using over 250 kilowatts) can receive a monthly credit of $36 per year for each kilowatt of load shed. A maximum of 50% of the load is eligible for load shedding credits. Credits are paid to the customer in monthly credits, of $3 per kilowatt, starting with the October billing. Twenty-two customers participate in this program. All customers in this program have meters that can calculate the reduction in load. It is estimated that this program can reduce peak load by 4.5 megawatts.
    c. Interruptible Rate: Columbia Water & Light provides a discount to large customers on the interruptible rate. The program provides a discount to the customer for interrupting usage when called on by the utility. There are currently two customers that participate in this program. These customers also have recording meters that can measure the reduction in load. It is estimated that 1.3 megawatts of load can be avoided through the Interruptible Rate program.

Time Based Rates for Smart Grid Applications

The PURPA standards refer to time based utility rates. This is a general term that gives customers incentives for offsetting electric use during times of high electric prices. There are several different approaches for determining the price of electricity at any given time.

The different ways of buying electricity on the wholesale market are real-time, time-of-use and day-ahead pricing. Real time pricing is based on hourly pricing for each of the 8,760 hours in the year. Time-of-use pricing is based on setting prices for predetermined period of time for similar days (for example summer week days). The day-ahead market provides hourly pricing but it allows utilities to lock into a rate for energy purchases ahead of time so there is less volatility in the cost of energy.

The energy and reserve market of the Midwest Independent System Operator (MISO) provides both day-ahead and real-time markets. Columbia Water & Light has operated primarily in the day-ahead market because of the reduced pricing risks. Others utilities across the United States have found that there are advantages to this pricing system over time-of-use pricing when setting time based rates for customers. With day-ahead market based real-time pricing, the

customer knows well in advance what the hourly price will be and can choose to respond based on their budget and operational capabilities.

To establish hourly pricing for customer demand response, the automatic meter infrastructure and a secure database would need to be in place. Columbia Water & Light staff would need to conduct a detailed historic analysis of hourly prices for each customer classification. This data would be used to set a sample range of prices that a customer could expect. Data from the Midwest Independent System Operator (MISO) on the cost of energy would have to be transferred to the city and to the customer. Mechanisms for showing the electric prices to the customer online, through a dashboard device or via the phone would need to be established. There would need to be a base charge established so the electric customer is paying for the cost of delivering the power. A module would have to be added to the existing billing system. The estimated cost of the module is $39,000 with a $6,700 yearly maintenance fee. Additional staff needed to implement and track time based rates has not been calculated at this time.

Control of Electric Load

The Energy Independence and Security Act refers to controlling electric load for maximum efficiencies during times of high electric prices. Currently technology is being developed to control HVAC systems and major electric appliances. Time based rates could also help encourage people to charge their electric vehicles during non-peak hours. In order for Columbia Water & Light to incorporate these ideas into the utility's structure, an automatic meter infrastructure, a secure telecommunications network, an updated Energy Management System, time based rates and billing would need to be implemented. Technology would also have to be advanced in electronic controls and better saturation of electric vehicles would need to take place to gain real efficiencies and control the utility's load. The Columbia City Council would also need to consider how much of this load the utility would control and how much the consumer would manage.

FUNDING

At this time, the cost of a full smart grid system is the biggest barrier to entry for the city. The full integration of a smart grid in Columbia is a large financial undertaking. Basic initial projections put the project well over $31 million. This is a very rough estimate; further costs would need to be developed after receiving direction from the Water and Light Advisory Board and the Columbia City Council. There were many items not included in this initial estimate, for instance, staffing and marketing of new programs.

The PURPA standards request that utilities look into smart grid applications before investing in traditional systems. It is suggested to unroll these strategies over time. The effectiveness of these new technologies needs to be weighed against the cost of the investment. Reference manuals for complying with the PURPA standards suggest that when considering implementing the new standards, a utility must consider:

- Total costs
- Cost effectiveness
- Improved reliability
- Security
- System performance
- Societal benefit

PILOT PROJECTS

Rather than implement a smart grid system for all of Columbia right away, pilot projects would reduce the yearly financial impact and give the city time to evaluate the effectiveness of new technologies. A few pilot project ideas are listed below. If the Water & Light Advisory Board and the Columbia City Council want the utility to move forward with any of these ideas, staff members could come up with a business case for each idea before the next budget year.

Large Commercial and Industrial Electric Customers

Large General and Industrial rate classification customers have MV90 meters that track energy usage every 15 minutes. In fiscal year 2009, these customers purchased 28.9% of Columbia Water & Light's energy sales and 23.1% of the load. This customer classification would be the lowest cost pilot project for smart grid applications. The first step would be to transfer the data to a secure online service so customers could monitor energy and demand. Day-ahead hourly pricing could also be implemented but upgrades would need to be made to the city's meter data management and billing system. Security and privacy issues must also be addressed.

Small Commercial Electric Customers

For electric customers that fall into the Small General electric customer classification, new meters could be installed that measure energy usage at shorter intervals. This customer classification was not all upgraded to the automatic meter reading ERT meters. Rather than install these types of meters, a switch could be made to the automatic meter infrastructure. From there, a geographic area that included a large percentage of small commercial customers could be selected for a wireless mesh network. For customers to view the meter data, the data management system would have to be integrated. Time based rates for this customer class would involve establishing a mechanism for customer charges and upgrading the billing system. The privacy and the security when transferring the data must be reviewed.

Residential Electric Customers

Residential electric customers have all been upgraded to the automatic meter reading system with ERT meters over the last several years. There is a way of transferring this meter data to a dashboard device in the home or via a personal computer. These devices could be purchased and installed by the utility and sold to the customers who wanted the data. By charging each customer individually, the entire customer base, some of which might not want the information, would

not be responsible for the cost of the units. If more money was available, a geographic area could be selected to do a full pilot of smart grid applications. However, this would require the meters, data management system and a secure wireless network. If time based rates were implemented, a rate would have to be established and the billing system would have to be upgraded. Customers will need to be assured that any data transferred electronically is secure and be made aware that the data could be made public.

Pay-As-You-Go Electric Meters

Another option for small general and residential electric customers is to offer pay-as-you-go meters. In other cities, these meters have lead to decreased electric consumption. Pay-as-you-go meters allow the customers to purchase smart cards or tokens that would represent a monetary value of energy. The customer is provided an interface that is capable of uploading energy credits to the meter through a smart card. The meter shuts off after the credits (supplied through the smart card) are used. The customer pays for the electricity prior to using it and is much more aware of their daily usage and cost. Other utilities report that electric consumption often goes down for customers with these types of meters.

Reporting Usage Data and Sources of Energy

Currently, customers can request copies of their monthly billing history from the Utility Customer Service office. The information can also be obtained online through the electronic billing system on the city's website through a secure connection. Another option is to put electric consumption data on the monthly paper bill. The current City of Columbia utility bill has a number of charges that need to appear on the paper bill due to the wide variety of services provided. This makes adding more information to the bill challenging. Columbia Water & Light, the Finance Department and Information Technologies (IT) staff meet to discuss the options available and the associated costs of changing the format. Any changes to the city's bill would have to be reviewed by the IT Steering Committee and the IT Director.

Adding an electric usage graph to the front of the bill would require 90 days of IT staff time. Adding the consumption graph to the front of the bill would not have any additional printing costs but space is very limited. A graph on the front of the bill could only be included for residential customers with one electric meter for a one month period. Currently the back of the bill has standard information printed ahead of time so the city only pays for specific data being printed on the front of the bill. Printing the consumption history on the back of the bill, where there is more room, would cost an extra $22,000 a year. Although there is an additional cost, there is more room so customer data for different rate classifications could have data displayed. Another option is to send out a separate mailing to customers with energy consumption data although monthly data along with the bill could be more effective in changing energy consumption habits.

Disseminating information on Columbia's energy and the CO2 emissions associated with that energy could be accomplished in a yearly public report or within the city's newsletter. Most of Columbia's power is purchased through contracts so there is not a huge fluctuation in sources of energy each month. A small percentage does come from the wholesale market which makes it hard to find the original source of energy. The sources of energy for each year are listed on the city's website. For the renewable portfolio, there is an annual public report to the City Council with details on each of the renewable sources. It is available by contacting the utility for a copy or by downloading it from the internet.