Business & Technology Report

May 2020

Turning Numbers Into Action:

Empowered Staff Drive Innovation Through Analytics

(Part 2 of 2)

NRECA

America's Electric Cooperatives

Business & Technology Report
May 2020

Turning Numbers Into Action:
Empowered Staff Drive Innovation Through Analytics
(Part 2 of 2)

Prepared By:

Bob Gibson
Gibson Energy Insights
Bob.Gibson-contractor@nreca.coop

NRECA Subject Matter Experts:

Adaora Ifebigh
Senior Manager R&D Engagements
Business and Technology Strategies
Adaora.Ifebigh@nreca.coop

David Pinney
Principal Analytical Tools & Software Products
Business and Technology Strategies
David.Pinney@nreca.coop

NRECA
America's Electric Cooperatives

Table of Contents

1. Executive Summary

What Has Changed?

Electric cooperatives are collecting enormous amounts of consumption and operational data every hour. The data collected from advanced meters can be used for much more than preparing monthly consumer bills. Applying analytics to this data reveals a broad range of actions that can save money and improve service. Analytics can be applied to all aspects of the cooperative business, from better detection of line losses, to staying ahead of the impact of changing weather patterns and consumer preferences.

What Is The Impact On Electric Cooperatives?

In an era of declining power sales and increased competition, the application of analytics – turning raw data into actionable programs – can mark the difference between struggle or success. Analytics empowers decision-making, allowing staff to better see and react to what is occurring on the utility system. In advanced applications, analytics can help cooperatives anticipate change, leading to accurate and timely investment in resources and programs.

What Do Co-ops Need To Know/Do About It?

The sheer volume of data pouring into the databases of the average electric cooperative can be intimidating. Cooperatives need employees who are comfortable with data and software, and capable of running queries that sift and sort for the information essential for effective action. The expanding suite of information software available through trusted partners makes basic analytics accessible to cooperatives of all sizes and consumer demographics.

1. Introduction

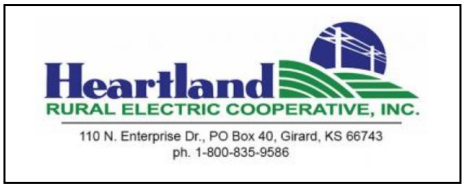
Much of the attention in prescribing effective approaches to data analytics focuses on the tools – the many software programs that have and are continuing to be developed to help utilities harvest and pull answers out of system and consumer data. But, the most critical component for electric cooperatives may be the human factor. This second of two NRECA reports on data analytics highlights the innovations underway at small and medium-sized electric cooperatives. These innovations depend less on the tools at hand than on the creativity and industry of the users.

Most electric cooperatives have at least the basic resources in place to conduct data analytics. As covered in Part One of this report, the majority of co-ops have installed or are installing an advanced metering infrastructure (AMI), which brings an unprecedented volume of data into the cooperative from smart meters. A cooperative's IT enterprise vendor offers a suite of data management tools, including customer information system and meter data management software. These and other vendors supply co-ops with additional tools, such as outage management and geographical information system (GIS) software. With GIS, detailed information about the utility system is displayed on maps that not only aid system engineers and operators, but turn hard-to-read spreadsheets into viewer-friendly reports easily understood by non-technical staff and members of co-op boards of directors. Electric cooperatives of all sizes are regularly contacted by vendors offering a variety of specialized software tools designed to sift and sort raw data for actionable intelligence.

The greater limiting factor is one of human resources. The smaller the co-op, the less likely it will be to have in-house staff trained in information technology (IT). A combination of lean budgets and a lack of awareness of the fast-growing importance of IT capability to efficient and effective electric utility service may create a barrier to advancing data analytics. In interviews for this report, some cooperatives believed that the relative lack of IT experience at smaller cooperatives presented a barrier to taking on analytics, with suggestions that larger cooperatives could more easily afford to add IT skills to their staffs required to perform analytics.

However, some small cooperatives are achieving success in analytics despite their size. Noble REMC in Indiana is one of the cooperatives profiled in Part One of this report. Though it serves just 11,161 members, Noble REMC, with support from its enterprise IT vendor, is saving money and improving service through applied data analytics. Also, Wheat Belt Public Power, a Nebraska co-op with 5,016 members, added a data scientist to its staff.

2. Finding and Empowering Employees Who Have "The Right Stuff"



Being a smaller cooperative may actually hold some advantages when it comes to innovations with data analysis. That is the opinion of Mark Scheibe, CEO of Heartland Rural Electric Cooperative, a cooperative with 11,302 members in Girard, Kansas. "Is size a real barrier? I think the opposite is true," he says. "I believe that the larger you are, the more difficult it is to initiate the use of data analytics to meet the needs at that co-op."

Scheibe's reasoning is that "a smaller co-op can be nimbler" – almost out of necessity. "People at a smaller co-op wear multiple hats," he says, and as a result must have a handle on different parts of the co-op's operations.

Scheibe's cooperative history provides a telling example of how data analytics capabilities can be developed internally, without hiring IT expertise. Before ascending to the top job at Heartland REC, Scheibe spent 12 years in various engineering roles at Maquoketa Valley Rural Electric Cooperative, a system of 16,118 members in Anamosa, Iowa. In this job, Scheibe credits his senior management with giving him "free rein to do things with data to provide value to members and assistance to our line crews as they responded to outages." He saw that the co-op, through its AMI and SCADA, was pulling in lots of real time data that contained untapped information about the system.

The sheer amount of data was enormous and potentially intimidating. Scheibe kept his focus on a handful of answers to problems that might be found by applying a filter to all that information. For example, one goal was to identify weak spots in the physical infrastructure of the co-op distribution grid. Scheibe thought that this might be done by identifying and studying the transformers that had burned out over the past five years. "What could we do to prevent future overloads by studying where and why transformers had failed? What patterns might emerge, from AMI data mapped by our GIS?"

Scheibe looked at it as a math problem that could be solved if he sent the right queries to the co-op database. Without a background in advanced software programming, Scheibe started with what he knew – Microsoft Excel and Visual Basic – and an aptitude for and confidence in computer software.

"I wrote a program in that and found I could begin to manage data a little more efficiently. Then, I learned Microsoft Access. What took me a couple hours in Basic, I could accomplish in minutes in Access." As Scheibe took on more demanding queries, Access was no longer enough – so he learned SQL (short for structured query language, with versions available from a variety of vendors). "Once I was using it, I could run something in SQL in five seconds that took 45 minutes in Access." The key, he says, is to start with an example of what you would like to accomplish and approach it in a stair-step fashion, starting easy at a base level and building from there.

Scheibe believes that many other smaller cooperatives can also accomplish big things with data analysis. "It starts with finding the right person on your staff, one with a natural curiosity about numbers and data, and a willingness to learn," he says. "With a desire to get things done, and the support and encouragement from above, it can be done."

3. Four Case Studies

The following case studies look at how four cooperatives are working to use data analytics to improve a variety of core operational and consumer-facing functions.

- ***Case Studies #1 & #2 – Sussex REC, New Jersey and Cornhusker PPD, Nebraska***

Sussex Rural Electric Cooperative, an 11,700-member system in Sussex, New Jersey and Cornhusker Public Power District, serving 10,000 consumers from its headquarters in Columbus, Nebraska, both have arrived at the same conclusion when faced with operational challenges – 'Hey, we can build an app for that.'

Whether it is better tracking of tree-trimming in New Jersey or streamlining applications to the Federal Emergency Management Agency in Nebraska, both consumer-owned utilities came up with their own computer-based applications. These apps were created in-house by co-op staff without the use of expensive software or experience as programmers.

"We don't have a lot of money to throw at every problem, so we try to figure things out on our own," says Claudia Raffey, director of marketing and member services at Sussex REC. "Then, when you learn to do it yourself in one area, you find yourself thinking, "hey, look at what *else* we can do." That's a mantra you find at all co-ops."

Sussex REC serves a rural, forested area about an hour west of New York City. Rich St. John, Project Engineer, emphasizes that he is "an electrical engineer, not an IT guy." But, he is recognized at Sussex REC as a person who has a knack for using software. Since he is part-time and "not involved in the day-to-day grind," he gets the call when special projects need attention.

This was the situation in 2018 when the co-op found that its reliance on paper reports to track and manage its tree-trimming cycle was causing inefficiency and costly delays.

"The charge I had was to come up with a [computer-based solution] that avoided purchasing another tool. It was all about leveraging what we already had," he explained.

St. John talked to everyone involved, from the contracted tree-trimming crews, to the co-op staff tasked with quality assurance checks, to the member service staff who handle member questions and complaints. He then created a computer-based app to enter and track tree-trimming activities. The app could be used to produce reports and populate dashboards "with one simple rule – that we would not code anything." It leveraged the tools resident in the GIS program that Sussex REC accesses from ESRI as part of its outage management software license with MilSoft.

With the in-house app, the tree-trimming crews use mobile devices to track their work as it is executed, populating fields in the app with information such as the date and location of trimming, permissions granted, and names of landowners encountered. With a cycle of 130 miles of tree-trimming undertaken every year, progress is recorded in segments of less than 500 feet and visible to all through the app.

The result? "We never touch a piece of paper from the tree-trimming company," says St. John. "Everyone enters information on the app, and only about things they did themselves. Our clerks no longer are handed a piece of paper scribbled with results from the QA folks."

Previously, when tree trimming was tracked on paper records, review and correction of a problem could take six months. "Now, our engineers have the information in their trucks on their I-Pads and Surfaces. When we do the inspection, if the work doesn't meet spec, that's recorded – and the tree trimmers see it and they then address it immediately."

There are limits to the app, but it serves the need at Sussex REC. "If I had to scale this up tenfold – if we had multiple tree trimming contractors – that could be a problem," says St. John. "We'd have to trust the contractors to not overwrite each other's data. But, since we only have one tree trimming company, this solution is working well."

It took about two months after the conversion from paper to computer for the impact of the change to sink in. "That's when we started to see the information showing up on the map – what's due to be cut this year, where the crew is today, which segments flunked inspection," says St. John. "The insights you get from that visual are amazing."

While Rich St. John and Sussex REC have produced many in-house apps (with the tree trimming and a second "blink" outage mapping apps being the most widely used), the staff at Cornhusker PPD in east central Nebraska have developed 30 apps over the past five years. Brett Olson, communications supervisor at Cornhusker PPD, says that even without an in-house software

development team, “the possibilities are endless” thanks to open platform tools that provide drag-and-drop app building. “We don’t have to be stuck with a product out of the box that doesn’t quite work for us. We’d rather build it on our side.”

In addition to FEMA reporting, the apps cover a variety of tasks including vegetation management, line inspections and transformer change-outs. Brett Olson, Cornhusker PPD’s communications supervisor has an IT background and provides technical support to several lineworkers and meter technicians at the utility, the ones who are making daily use of the tools through the computer tablets carried in their trucks (see Figure 1).

Figure 1: Lineworker App In Use
Courtesy of Cornhusker PPD

Recovering from recent natural disasters greatly ramped up the burden of filing information with FEMA. “It may sound cheesy, but it was really a matter of me saying to the guys, “what can I do to make your job better?” says Olson. “I don’t think most people were used to being asked that. It turns out that they had great ideas. So, we created our own solutions.”

Moving from paper reports that get filed in a cabinet to entering and managing GIS-based data on tablets and storing that information in the cloud was readily embraced by Cornhusker’s outside personnel. “Almost everybody now expects a digital experience – they don’t want paper and pencil,” says Olson. And, not just paper. Utility staff as well as contractors use the apps, which have replaced people bringing information to the office on thumb drives or emailing changes.

Olson helped the lineworkers and other operations staff work through the software process. “Now, they can take it from there,” he says. “They design it, they see the benefits and they own it – 100 percent.”

- ***Case study #3 – Horry Electric Cooperative, South Carolina***

Horry Electric Cooperative, Inc.
A Touchstone Energy® Cooperative

While the smaller electric cooperatives profiled to this point provide examples of innovation in analytics without the need for in-house resources, such as software programmers, Horry Electric Cooperative offers a very different take on what co-ops can accomplish on their own.

Instead of primarily relying on purchased software tools to manage and analyze data, several years ago this 72,000-member co-op headquartered in Conway, South Carolina, decided to build its own solutions, and to do it with a team that includes full-time, trained software developers. The result, notes Brian Swart, Horry EC's software development supervisor, has been the development of 200 dashboards and apps, "all used daily," he says, to help the co-op improve operational efficiency, anticipate issues on both the member and co-op sides of the meter, and to improve the member experience in doing business with their utility. Examples include:

- **Calculating line losses by substation** and using data analysis to quickly identify which substations are incurring the highest losses and are candidates for proactive upgrades. "This is not something we want an engineer to have to spend two weeks figuring out, when it's three clicks away [using our program]," Swart says.

- **Developing an algorithm that analyzes member power usage**, sifting through anomalies to detect costly issues on the member side of the meter, such as a faulty heat strip in a heat pump, failing water heaters or a leaky hot water faucet. These are spotted in a report run by the co-op's billing supervisor twice weekly. In the past, many of these problems would have only surfaced when a high bill complaint was registered, and the underlying issue a month or two in the making. "We now have a 98 percent success rate in identifying high bills [before they are reported], and we're finding them within three to five days," he says.

  The graphs on the following page provide example of detection of abnormal energy usage, notification to the member and the resulting change in usage level (Figure 2).

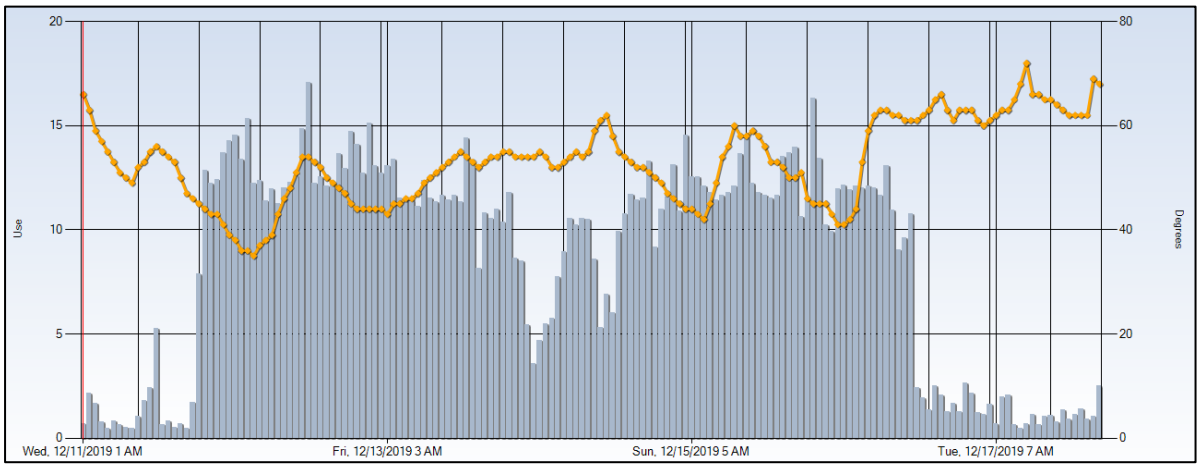


Figure 2: Hourly readings for a member from 12/11/2019 – 12/17/2019. Issues were starting around 12/11 at 8 PM. Analysis below. Courtesy of Horry EC

Analysis Date: Saturday, 12/14 – *The member was flagged by the algorithm on 12/14 and received a score of 8.36 (the +8.36 shows an increase from the prior day).*

Location	Account	Member	Rate	Valid Reads			Historical	Use	% Increase
[redacted]			3	15	Current Use	186	Period	125	149
		Abnormal Score +8.36 8.36			Connected	11/14/17	Last Month	88	212
		Current Base Load 1.80			Address Match	Yes	Last Year	79	235
		Period Base Load 2.19			Hourly %	131	Rate	40	462

Analysis Date: Sunday, 12/15 – *The member's use dropped for some time, so the score dropped accordingly. -0.59 shows a decrease from the prior day.*

Location	Account	Member	Rate	Valid Reads			Historical	Use	% Increase
[redacted]			3	15	Current Use	237	Period	116	204
		Abnormal Score -0.59 7.76			Connected	11/14/17	Last Month	92	256
		Current Base Load 5.67			Address Match	Yes	Last Year	79	298
		Period Base Load 1.80			Hourly %	197	Rate	41	580

Analysis Date: Monday, 12/16 – *The use went back up and the score increased dramatically. The member is notified of the issue at 11:35 AM. Use drops to 2.4 kW by 6 PM*

Location	Account	Member	Rate	Valid Reads			Historical	Use	% Increase
25246019	6586-001N*	FELDER WANDA L	3	15	Current Use	262	Period	117	225
		Abnormal Score +18.51 26.27			Connected	11/14/17	Last Month	99	266
		Current Base Load 8.20			Address Match	Yes	Last Year	81	323
		Period Base Load 1.68			Hourly %	217	Rate	41	638

Analysis Date: Tuesday, 12/17 – *The member is no longer being predicted by the model. They will drop off the report on 12/18.*

Location	Account	Member	Rate	Valid Reads			Historical	Use	% Increase
[redacted]			3	15	Current Use	205	Period	132	155
		Abnormal Score -26.27			Connected	11/14/17	Last Month	102	201
		Current Base Load 3.44			Address Match	Yes	Last Year	88	232
		Period Base Load 1.42			Hourly %	147	Rate	40	509

- **Reducing member payments handled as walk-ins** at co-op offices and moving about 10 percent of member payments to participating local banks, which use a program developed at Horry EC to automatically credit the member's account in the cooperative's customer information software maintained by its enterprise IT vendor, SEDC. This has significantly reduced the time and costs of handling the transactions at the co-op and has moved welcome traffic to local banks.

Everything that Horry EC is doing with data is pretty unique in the cooperative world, including recent advances into the realm of machine learning. More than 15 years ago, the cooperative found that it had needs that the major IT providers at the time could not address. So, it began building its own solutions and has never looked back. When Swart joined the staff at Horry EC in 2007, he and his team moved to an iterative, team-oriented software development method known as Agile.

Yet Horry EC does not "go it alone" when it comes to software. It makes use of the basic suite of data services common to all cooperatives, including AMI, outage management and CIS. "We are not competing with vendors, and we don't try and circumvent any integrations among any of our IT partners," says Swart. He explains that Horry EC utilizes what each vendor does best, and conducts "complementary customizations" with its in-house resources, consistent with their vendor agreements. Cooperatives should review their vendor agreements accordingly to understand the terms around customizations, if any.

A key to the success of data analytics at Horry EC revolves around the status that the IT department has earned within the cooperative hierarchy. "We've built a reputation within the cooperative and we're making an impact," Swart says. "A lot of what we do starts with listening. I get included in a lot of meetings and conversations with other departments. I can apply my experience in using data to see things we could be doing better, before people even ask for it."

For the electricity business and information technology, Swart believes that the hardware issues are getting easier to manage, but software is becoming a bigger and more difficult challenge. "I got lucky to be able to start my career at a co-op that saw the importance of data at a time when most co-ops did not see the value in that," he says. "I think co-ops will eventually shift the focus of IT from hardware to software and data science and analysis."

- ***Case Study #4 – United Power, Colorado***

Data analysis is not new to United Power, a fast-growing cooperative of 94,000 members headquartered in Brighton, Colorado. But, the impact of data analysis on the daily nature of work – and the relative productivity of that work – has changed enormously.

"We've always done analytics," says Tyler Bain, an engineer on the staff at United Power." At some level, you can't properly operate the electric grid without it. But, our efficiency and productivity with analytics has increased quite a lot in the past few years. We are doing a lot more with relatively little increase in human effort. With the tools we have now – many of them models that we have built – we can digest a lot more actionable information from our data streams. As a result, we've switched to being much more proactive than reactive. We see what's occurring in real-time at the device level."

The biggest leap came with the advent of AMI in 2013. The advanced digital meters replaced monthly meter readings with fifteen-minute interval data four times an hour and delivered via daily schedule or on-demand reads. The AMI data flow, combined with the information collected into the co-op's SCADA system from hundreds of devices on the grid, made it feel "like we were drowning in data," says Bain. In response, the United Power engineering and IT staff built analytical models from a variety of software tools to sift and sort the data for usable information. It was all fed into a geographical information system (GIS), which is at the heart of the cooperative's data management efforts.

It took United Power a decade and regular efforts from as many as 30 GIS professionals, engineers, system operators and system designers to build its customized GIS model, says Bain. The GIS maps both the co-op's electric grid and its fiber network and is the platform for determining and tracking system upgrades and construction projects. Refinements to the GIS are ongoing, with updates made daily. United Power uses analytics for a wide range of issues, from improved outage response to planning infrastructure growth. A somewhat unique, but increasingly important application, is in response to the growth of solar power.

A Tool to Shape the Impact of Solar Growth

Data analytics is helping United Power manage its significant amount of both utility-managed and member-owned solar power. What it is learning provides a template for other cooperatives as distributed energy – including solar, battery

storage and electric vehicles – grows into a more significant factor in the management of cooperative grids.

Solar production within the United Power service area can top 50 MW on peak production days, or slightly less than 10 percent of the cooperative's load. This includes close to 28 MW of customer-sited solar and 37 MW of solar sited in its service territory that United Power procures through power purchase agreements (PPA) to meet member demand. See Figure 3 for example.

Figure 3: Ft. Lupton Solar
Courtesy of United Power

"Without data analytics, we could not have as optimistic an outlook on our ability to manage an intermittent resource like solar," says Bain. The cooperative built software tools that allow it to monitor its purchased wholesale solar through the SCADA, as well as the ability to conduct real-time controls. "If the solar production is detrimental to our system, we can curtail generation, dialing it up and down in an automated fashion."

While the cooperative cannot control solar installed by members in a similar fashion, "data gives us visibility into how that solar may impact our overall system, and we can make accommodations." With what Bain refers to as "our home-brewed dashboards," solar and battery storage are visible in real-time in the co-op's SCADA system. See Figures 4, 5 and 6 on the following pages for examples of United Power's solar data analytics.

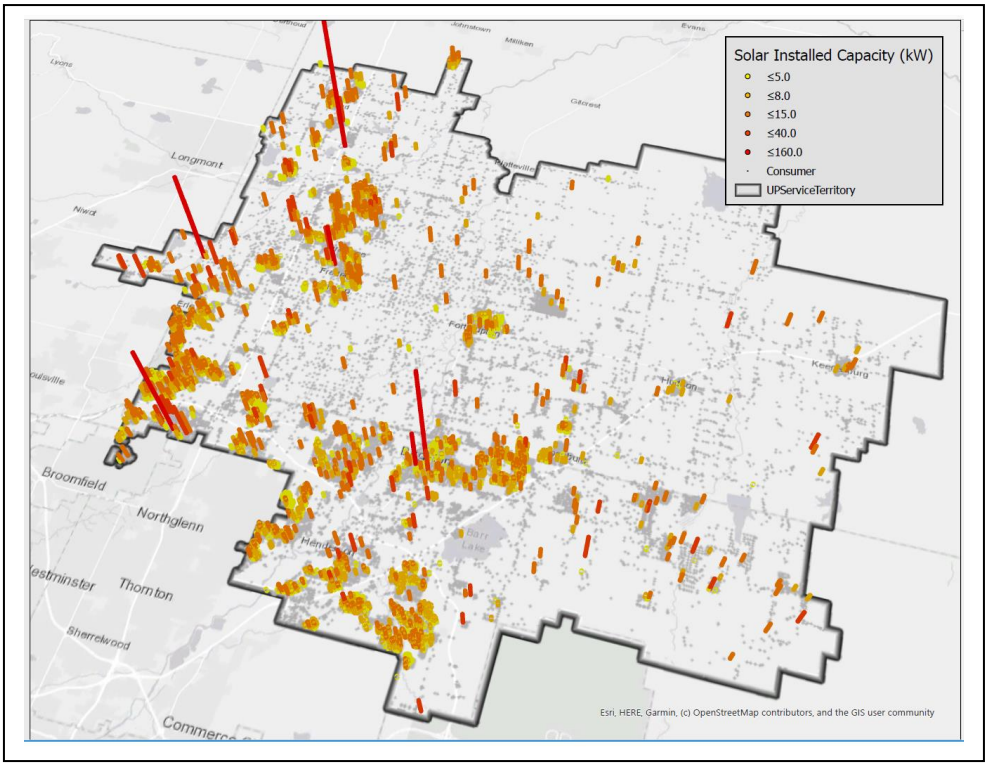


Figure 4:
Rooftop Solar Installed (kW)
(Image courtesy of United Power.

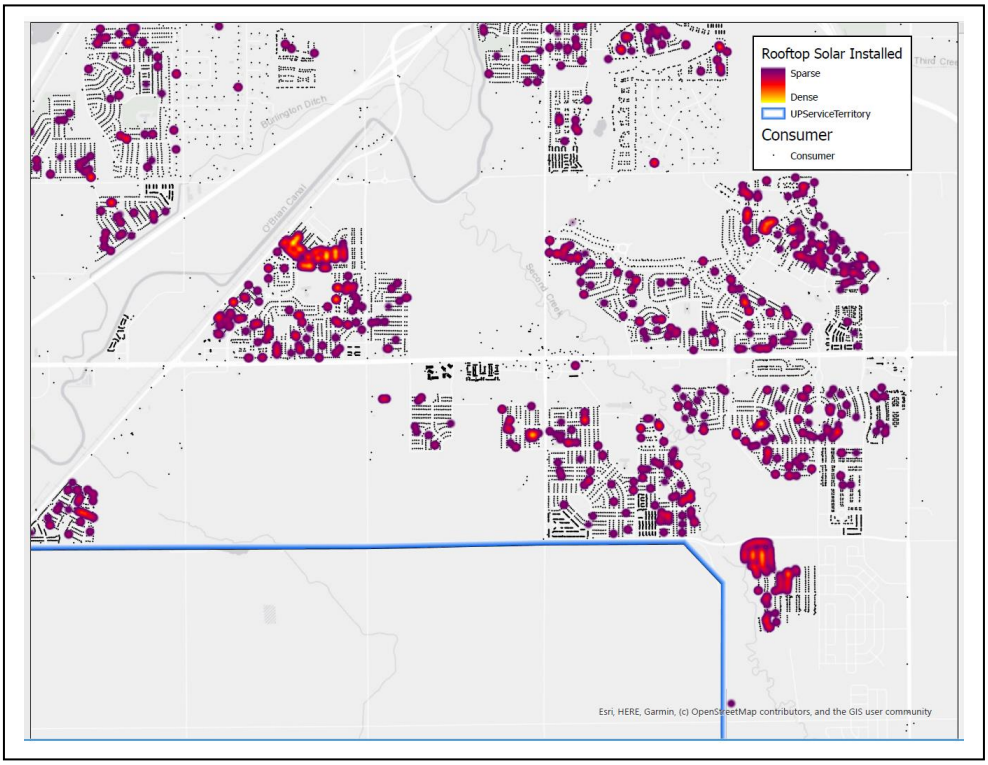


Figure 5:
Rooftop Solar Installed - Weighted (kW)
(Image courtesy of United Power.

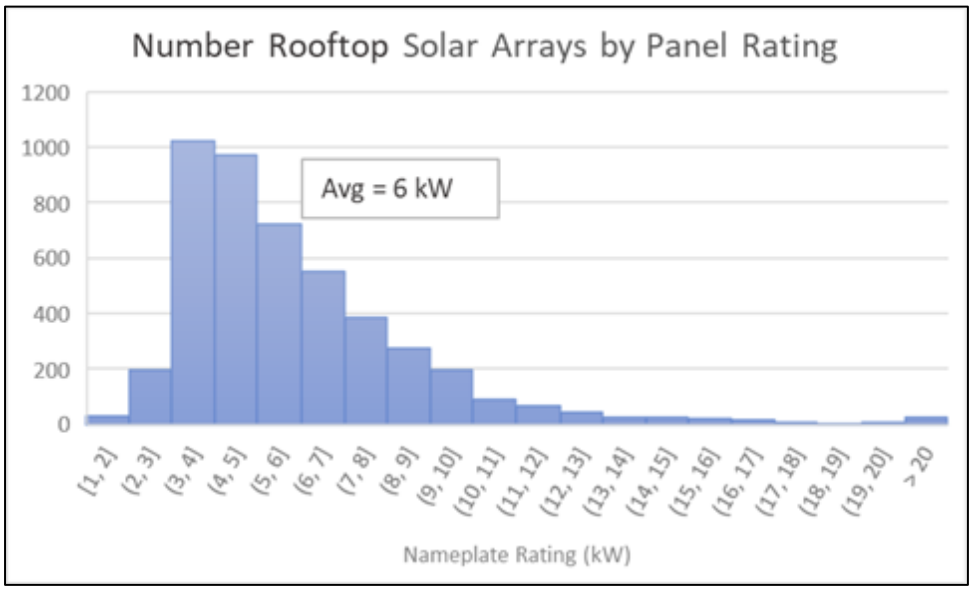


Figure 6 (Image courtesy of United Power.)

United Power believes that its focus on real-time data analytics will pay off in an ability to not just monitor and accommodate customer-sited solar, but to optimize a variety of tools to help manage electricity demand peaks. This includes storing daytime solar output in batteries that can be dispatched to lower late afternoon and early evening peaks, to pre-cool homes through signals sent to smart thermostats, and to manage the charging of electric vehicles to take advantage of lower-cost off-peak power.

It's not an easy job. "Data analysis is definitely a science – but there is art involved too, in the decisions we make. We sometimes hear, 'more data, more problems'," says Bain. "Really, the accurate view is 'more data, more visibility.' The problems were always there – we just didn't have a way to know or track them like we do now."

Expanding Sources of Data Aid Co-op Planning

Electric cooperatives are looking beyond the "obvious" sources of data that come directly from within the utility system – AMI and all the devices that communicate through the SCADA – to outside, publicly accessible databases that yield information directly pertinent to the co-op's strategic planning.

At United Power, a significant industrial load comes from the oil and gas industry. These appear as a "point load layer" in the GIS system, and permit requests for new installations can create bottlenecks, if not accounted for in advance.

United Power engineer Tyler Bain says that the co-op now monitors the oil and gas permits filed with the state and enters that data into GIS to add precision to its awareness of anticipated load growth.

In 2018, Oklahoma legalized the sale of medical marijuana and began permitting businesses to supply the product. Northeast Oklahoma Electric Cooperative cross-referenced data available from the state about registered grow houses to its service area. This revealed 1,000 grow houses expected to be sited on co-op lines. As a result, Northeast Oklahoma has flagged those sites and is studying the potential impact on transformer loading.

4. What's Next for Data Analytics?

As the area of analytics continues to evolve and mature, there are some key effects that are currently evident:

- **It will impact the human resource needs at electric cooperatives.**

  "It will change what we're looking for in employees," says Daniel Webster, CEO at Northeast Oklahoma Electric Cooperative. Webster himself is one of a growing number of co-op CEOs with an IT background. He says that analytics will focus attention on both people who have specialized training in IT systems, but also those who simply have an "analytical mindset – in effect, an amateur data scientist. We'll need someone who understands how having data, and information from our data, applies to our giving the best service to our members."

- **It will expand its value throughout the utility operation.**

  Among the new and growing areas for data analytics include in the use of unmanned aerial systems (UAS; i.e., drones) as part of grid management, enhancing visibility into voltage profiles at every point in the grid, increasing the accuracy in measuring the true impact of load management and demand response initiatives, easing the integration of distributed energy resources, and in improved understanding of member preferences through consumer segmentation. NRECA is monitoring and reporting on UAS technology and applications by cooperatives. Visit cooperative.com for more information.

- **There will be continued progress towards machine learning and the use of artificial intelligence.**

  A handful of cooperatives are beginning to use machine learning in analytics. This will evolve into the deployment of computer models that not only can recognize and report on trends and anomalies, but can initiate changes and take corrective action without direct human interaction.

NRECA will continue to monitor and report on cooperative efforts to use data and analytics to empower decision-making, anticipate change, and make accurate and timely investment in resources and programs. We will explore options to engage with co-ops on projects that advance the subject, and share lessons learned and opportunities with the wider co-op community. NRECA continues to work with the Federal government, national labs, universities and for-profit organizations on research projects to advance data analytics in the utility space. This work is

informed and guided by a group of cooperative advisors in the Analytics, Resiliency and Reliability work group.

Additional Resources

- Turning Numbers Into Action: Analytics Brings Visibility To Utility Operations, Clarity To Decision-Making (Part 1 of 2)
- 2019 Co-op Technology Survey
- Data and Analytics Website
- Analytics, Resiliency and Reliability Work Group