Business & Technology Surveillance

# Coles-Moultrie Electric Cooperative Taps the Value of Open Source GIS

By Deborah K. Fish, PE

AUGUST 2018

NRECA
America's Electric Cooperatives

Business & Technology Surveillance

# Coles-Moultrie Electric Cooperative Taps the Value of Open Source GIS

By Deborah K. Fish, PE

## AUGUST 2018


**SUBJECT MATTER EXPERT ON THIS TOPIC**

**David Pinney**
Program Manager Analytics, NRECA Business and Technology Strategies, David.Pinney@nreca.coop

**Robbin Christianson**
Senior Product Strategy Manager, NRECA Business and Technology Strategies,
Robbin.Christianson@nreca.coop

This article is a product of the Analytics, Resiliency and Reliability Workgroup.


**SNAPSHOT:**

### WHAT HAS CHANGED?

Open source software is not new. It emerged in the 1980s and is used by every major software company like *Google, Facebook, Amazon*, *Ebay*, and *Craigslist*, and by companies and government agencies like *IBM*, *Disney*, *NASA*, and *AT&T*. What has changed is cooperative IT departments' perceptions about open source. Ten years ago, cooperatives viewed open source as a risk. Now that open source software has proven track records, the question is no longer "is this a risk?" but more often "is there open source software that can solve this problem?"

### WHAT IS THE IMPACT ON COOPERATIVES?

Co-ops are looking to advance how they can use data for operational and productivity gains, and different paths suit different cooperatives. NRECA members have expressed ongoing interest in seeing different approaches cooperatives use to deploy technology and to problem-solve. Additionally, with the rising gap in qualified workers, sharing stories of creative solutions to strategically source technical talent is of increasing value.

Coles-Moultrie Electric Cooperative in Mattoon, IL, (CMEC) developed its own Geographic Information System (GIS) from open source software in less than a year. The co-op also leveraged Lake Land College, hiring and training Geospatial Technology students to support development of the system.


NRECA
America's Electric Cooperatives

## WHAT DO CO-OPS NEED TO KNOW AND DO?

This 9,000-meter co-op has taken a creative approach to develop a GIS using Open Source software while partnering with a nearby community college. Through an intern program, the local community college provided students to help develop Coles-Moultrie's successful in-house GIS in a short amount of time. This project is just one example of outreach programs to support local communities served by co-ops. The GIS—developed at a low cost to the co-op—is popular with co-op employees and being enhanced continuously. Following the development of the Coles-Moultrie project, this effort demonstrates that even when budgets are tight, paths may exist to enable new capabilities provided by digital maps and GIS.

## Introduction

Coles-Moultrie Electric Cooperative (CMEC) wanted to move from paper maps to a digital GIS. They hired a GIS professional, Shaun Vester, who had GIS and programming experience. He wanted to try open source software and started by participating in the social coding platform GitHub, which is a community of developers with varying degrees of expertise to share and build software. After initial investigation, based on CMEC's workflow and immediate needs, CMEC decided to give open source software a try.

## Background — Decision for QGIS

Paper maps are still used by approximately 20 percent of all co-ops.

Although paper maps might seem like a relic to some, paper maps are still used both in the office and in the field for approximately 20 percent of all co-ops. Coles-Moultrie EC, made a choice to use open source software, instead of the traditional ESRI or other GIS platforms readily available off the shelf. CMEC's GIS system was developed using four (4) open source programs: (1) PostgreSQL; (2) QGIS (originally known as Quantum GIS); (3) PostGIS; and (4) LeafletJS. These are free tools for development. For those not familiar with these programs, a brief description from information provided by CMEC and taken directly from the companies' websites, along with links to the websites, are provided below:

1. **PostgreSQL** is an "open source object-relational database system with over 30 years of active development that has earned it a strong reputation for reliability, feature robustness, and performance." **www.postgresql.org**
2. **QGIS** is a "free and open source geographic information system that allows you to create, edit, visualize, analyze, and publish geospatial information on Windows, Mac, Linux, BSD)." **www.qgis.org**
3. **PostGIS** is a "spatial database extender for PostgreSQL object-relational database. It adds support for geographic objects, allowing location queries to be run in SQL." **www.postgis.net**
4. **Leaflet** is "an open source JavaScript library for mobile-friendly interactive maps. It works efficiently across all major desktop and mobile platforms, can be extended with plugins, has a beautiful and well-documented API and a simple, readable source code that is a joy to contribute to." **https://leafletjs.com**

All the open source programs are well-documented, ranging from 7 to 16 years of development. CMEC started with QGIS, which is licensed under the GNU (General Public License). The GNU General Public License (GNU GPL or GPL) is a widely used free software license, which guarantees end users the freedom to run, study, share, and modify the software. The QGIS website offers a User Guide and Training manual. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows, and Android and supports vector, raster, and database functionalities. QGIS was chosen because of its popularity, availability, openness, and immense functional abilities. QGIS also allowed CMEC to incorporate high resolution satellite imagery directly into the GIS work area through "OpenLayers." The variety of options is what allowed CMEC to pick and choose the functionality that best suited CMEC's existing workflow and needs. CMEC also did not modify or customize the source code of any of the programs, understanding the risk for maintaining the software.

Oftentimes, open source software is intimidating because it is created within a public domain, allowing anyone to modify or enhance.

Co-ops are investigating the use of open source software for many reasons, mostly because it is dynamic and collaborative technology that is available at less upfront cost. But, oftentimes, open source software is intimidating because it is created within a public domain, allowing anyone to modify or enhance. Another fear of open source software is support after customization. There are, however, companies that provide support and training on open source software. An example is Redhat, which distributes Linux based on open source development of the popular operating system. The four (4) open source websites referenced in this article include links to training, example answers, and searchable help menus.

Developing relationships and creating internship programs for local students can provide new and added technical skills to the cooperative at very low cost.

Although integrating and developing custom software sounds enticing, a word of caution is necessary. Undertaking this type of software development requires not only a strong GIS background, but experience with programming and a willingness to learn. Shaun Vester was a perfect fit for this type of challenge. In addition, projects like this need upper management support, and a culture of teamwork and encouragement is also essential for success. CMEC's CEO Kim Leftwich strongly supported this project, "Coles-Moultrie weighed the risks and benefits, and open source GIS was a perfect fit for our co-op." Of note is that many of these same challenges are true for modifying and integrating commercial software.

## GIS Data Cleanup

The first goal was to infuse the old with the new by migrating the information from the paper maps into the GIS database. One important aspect of paper maps is preserving handwritten notes and sketches. Once the data was digitally captured, the paper maps were obsolete. CMEC chose not to GPS data in the field. With the sub-meter accuracy of satellite imagery, the overhead assets were snapped to the background maps and the confidence level in the location of the assets is high. There is flexibility in the background or landbase maps behind the GIS.

Partnering with a nearby Lake Land College added extra resources to help with the initial time-consuming step. The internship was beneficial not only to CMEC, but it is now an ongoing relationship to support the College's GIS Associate Degree Program. Hundreds of cooperatives also live within an hour of a local community college. Developing relationships and creating internship programs for local students can provide new and added technical skills to the cooperative at very low cost.

After moving the data, like any GIS project, cleaning the data was the next step. Identifying the phase of equipment remains a constant struggle for most co-ops. CMEC checked the phasing of all equipment in the field against the digital maps. What is unique to CMEC's GIS is the graphical display of accurate phasing on all overhead lines within the GIS. This was not manually drawn. Instead, Shaun wrote an algorithm that determines the angle of the overhead lines and arranges the phasing in the correct order based on the angle. The screen shot below shows how the phasing automatically tumbles through angle poles (Figure 1).


**FIGURE 1: Phasing Through Angle Poles.** An example of tumbling phases, look at pole "L1F1-9" in the screen shot above. The green phase is on the west side of the line. When the line changes direction you can see that the green phase gets moved to the south instead of the north. In this case, the algorithm determines the line is going east, and it moved the phasing to the correct order.

## Project Makes Strides

Starting in May 2016, Coles-Moultrie launched its GIS project with the goal to move from paper maps to digital. Within months, the GIS was developed. The first goal was to allow everyone in the co-op access to the GIS data sharing data-driven maps, applications, templates, and tools. The second goal was to apply the maps and spatial reasoning to search for or explore the data in intuitive ways. Lastly, CMEC automated as many existing processes as possible, including real-time access to other software within the co-op.

CMEC realized that automating the existing processes within the co-op was easier than trying to change the process to fit an out-of-the-box software.

The approach was simple. Shaun describes the process best, "We started with an existing problem and tested solutions at different scales to discover which actions had the greatest impact." Through this experience developing what CMEC calls "The GIS," CMEC realized that automating the existing processes within the co-op was easier than trying to change the process to fit an out-of-the-box software. The simplicity of taking one process at a time can be advantageous to adding functionality. Teamwork is the key to CMEC's quick success. Jim Wallace, Director of Operations and Planning, "gets gears spinning," according to Shaun. He and other employees stop by on Monday mornings and ask, "Can we do X with Y and Z?" and that is how the process started. CMEC also prioritizes the problems based on the frequency of use. For example, the first priorities were writing practical reports through queries based on the number of times the information is needed or used. New to the electrical industry, Shaun said he learned quickly that "this Industry cares about outages, blinks, and power quality, so those were the first reports written into the GIS."

The GIS project was instrumental for positive community engagement and education.

An example of using the GIS to solve problems is CMEC's Avian Protection Plan, with more detail found on their website **www.cmec.coop**. CMEC worked with Douglas-Hart Nature Center, Lake Land College, and Eastern Illinois University to create an open source GIS where anyone can report any bird to the publicly available map. The GIS tracks statistics on birds such as hawks, eagles, owls, osprey, and ravens, that commonly use utility structures to perch. To report a bird sighting, the GIS tool can be accessed from a mobile device or a desktop computer, and is open to anyone. These sightings are reported to CMEC and are used by the co-op to determine if conversion from overhead to underground is necessary. This GIS is also used by the co-op to determine where to change construction units to avoid larger bird contacts. This environmental project was instrumental for positive community engagement and education.

## Functionality

CMEC's GIS has the functionality of any typical GIS, which includes menus, map layers, views, legends, vector data (X, Y), raster data (images), spatial analysis, and map production tools. The GIS has been customized specific to CMEC's requirements, including assembly units, wire types, map symbols, views, zooms, and landbase data or background imagery.

CMEC's GIS is **Web-based** in the field. It uses a web map, like Google Maps. CMEC has mobile hotspots throughout its territory and then 4G coverage in areas where the network is not available. Because CMEC's territory extends over nine counties, the flexibility between wireless 4G data and the co-ops' network for their field tool was an essential requirement.

## That Aha Moment

Shaun understands the importance of MultiSpeak.[1] He took a class at TechAdvantage in 2017, and it was overwhelming as he was just being introduced to electrical systems. He said, "it was hard to imagine how it was used in the real world, but the light has clicked on." Coles-Moultrie is now sharing and moving data with the MultiSpeak model. Shaun had that "ah-ha" moment when the training from last year made sense. CMEC pulls data from AMI and Accounting, and hopes to have the Outage information going to the maps in the next few weeks.

CMEC's GIS **interfaces with billing and accounting records**. The GIS migrates NISC's iVUE data once a day. The key component is

[1] MultiSpeak is the worldwide leading software interoperability standard and solution for electric utilities enabling data sharing between independent systems in a seamless, cost-effective, secure, and standardized way by simplifying software integration and minimizing expenses for custom interface solutions. For details, see **www.multispeak.org**.

that the meter data is now geo-referenced in the GIS. Now that the maps interface through MultiSpeak with billing, meters are updated daily. The GIS department no longer must chase down paperwork to find meter change outs. That was a lot of work that was many times lost in translation.

CMEC's GIS **interfaces with Automatic Vehicle Location (AVL)**. Shaun's team wanted to see vehicle locations in the GIS map. They took the NeoNytro AVL software and routed it through a server that listens and disseminates the information to a web address. The program essentially sniffs out network traffic and broadcasts information like the vehicle truck number, speed, and direction. Through reverse engineering, CMEC uses MultiSpeak to bring AVL information into its map that refreshes every 20 seconds. CMEC has GPS in all the vehicles. This was an important functionality to CMEC because of its co-op territory. They have had GPS in the trucks for some time now, but they were limited by the AVL software that could only be accessed from the office, and the maps did not have the electrical facilities. Now, everyone can see the location of other trucks from the GIS in the field. An example of the map from the AVL software is shown in the first picture below (Figure 2). You can see that the vehicle, "HH-13" is not visible from the AVL software.

Examples of the AVL system capabilities from CMEC's GIS are shown in **Figure 3**, **Figure 4**, and **Figure 5**.

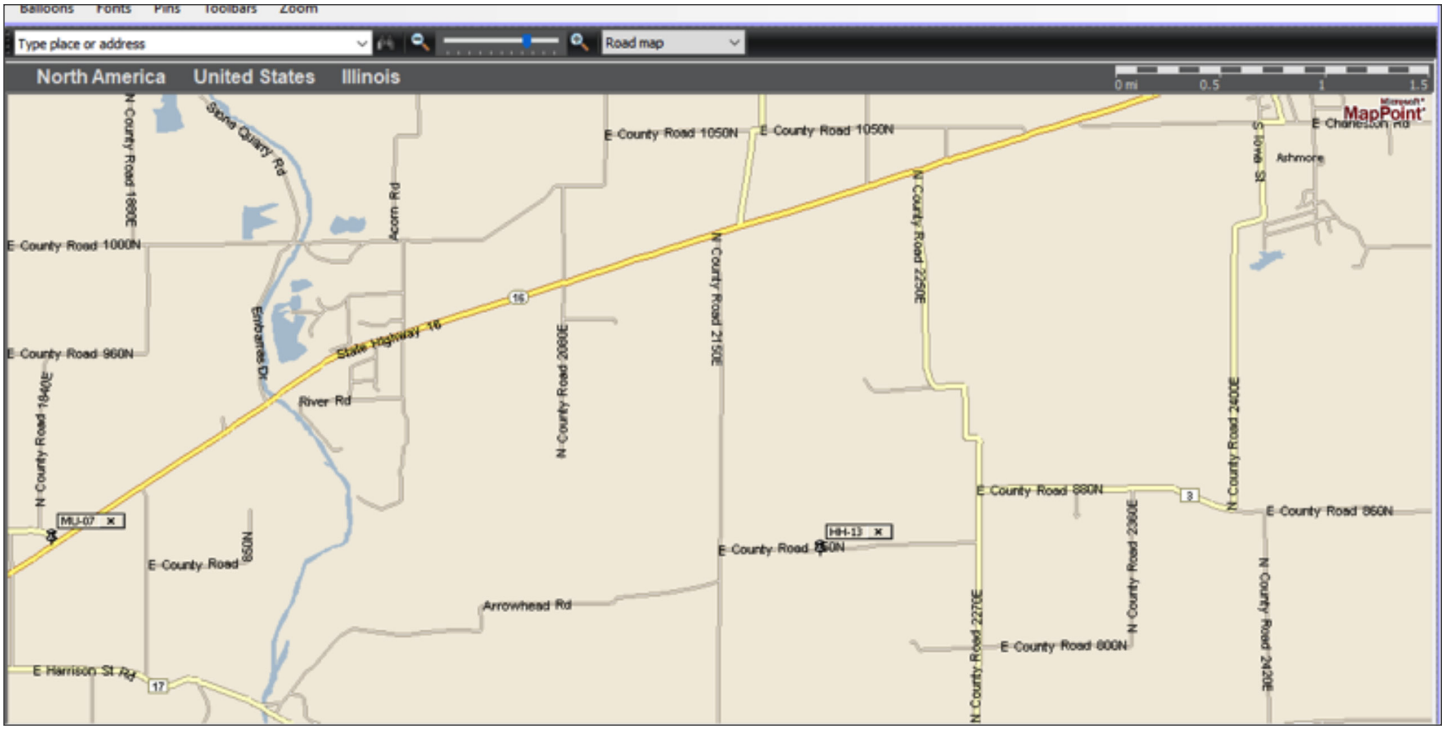


**FIGURE 2: Example of Map from AVL Software.** The file NeoNytro.png is CMEC's current AVL software without poles or electrical facilities.


**FIGURE 3: AVL System from CMEC's GIS.** AVL Snip.png shows the AVL system from CMEC's GIS, which CMEC's field staff now access. "HH-13" in this image (and the rest) is represented by a green triangle.

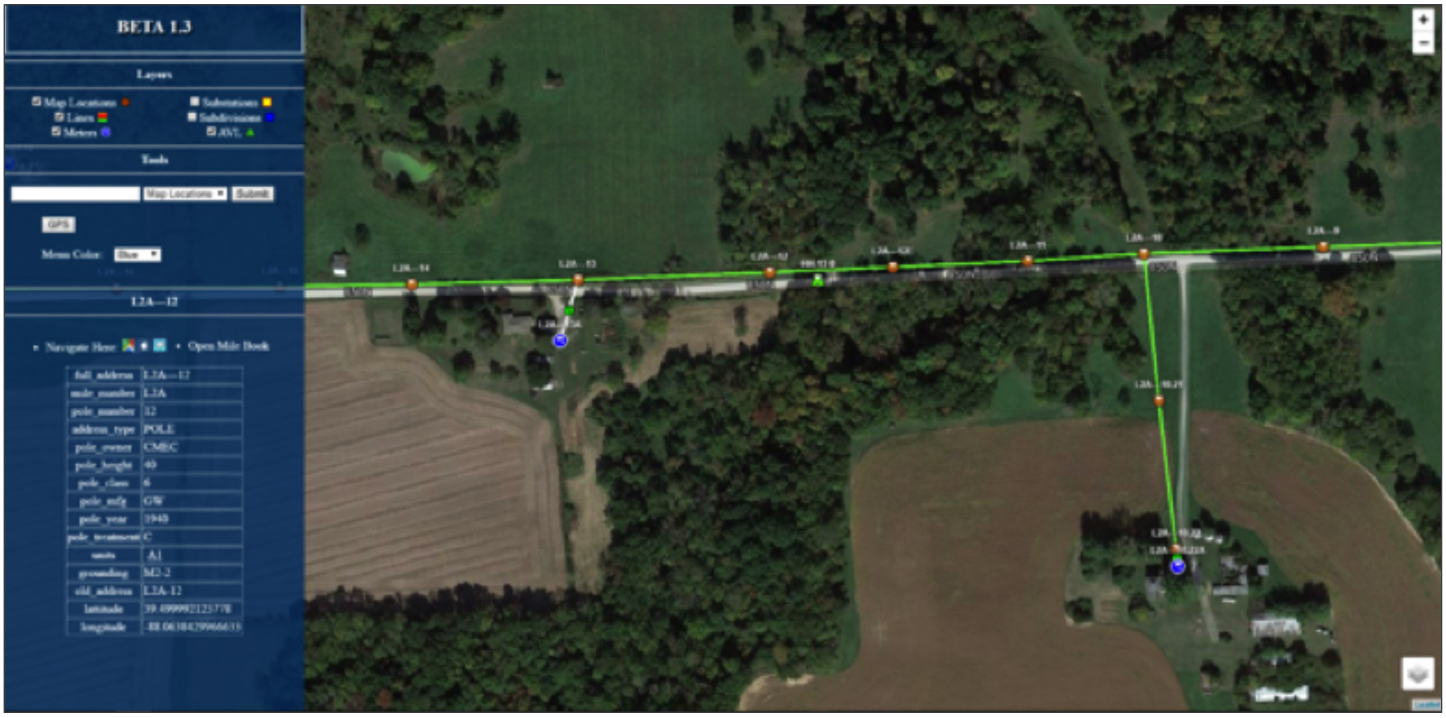


**FIGURE 4: AVL Pole Information.** AVL Pole Info Snip.png shows on the left side of the screen the information that appears when a user clicks on a pole. In this case the pole selected is L2A-12.

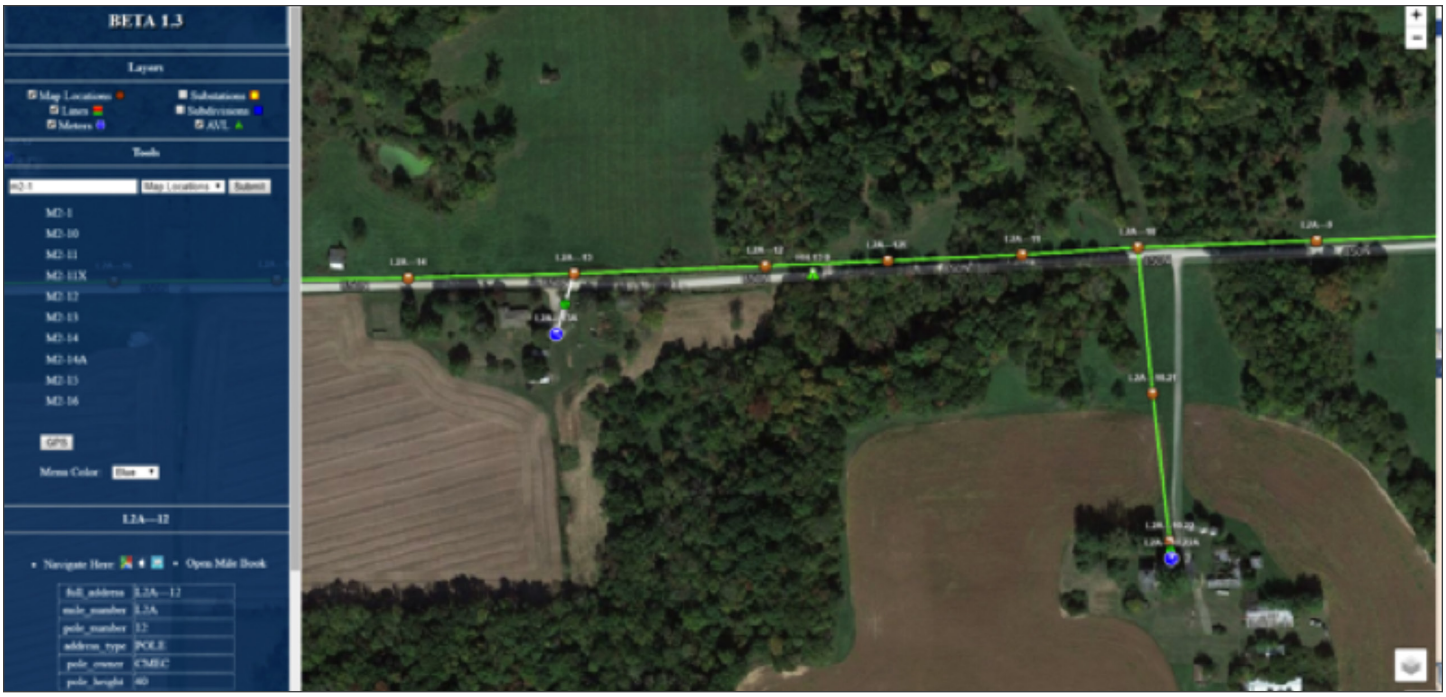


**FIGURE 5: Example of AVL Search Capability.** AVL search info.png shows the search capabilities built into the GIS. In this case, the user is doing a search for the pole "m2-1", and the closest results are populated below the search bar.

CMEC is currently exploring how to observe cutoffs for non-payment from the GIS map.... The advantage is that the GIS is available to every on-call lineman from home or their mobile device.

CMEC's GIS **interfaces with Outage Management Software (OMS)**—Still under construction, CMEC anticipates NISC's OMS interface to be finished this summer or fall. Using the same process as the AVL interface, CMEC will use the server to listen for outage requests and show these locations real-time on the GIS map. NISC's OMS currently uses Milsoft's WindMil model to predict the open device. Once a call is received, if the meter or customer information is correct, the software searches for the next overcurrent device upline using the section by section WindMil model. David Welsh, SCADA and Engineering Technician explains, "Although this method works, using AMI meter data to verify the exact meter location is more precise, because NISC's OMS does not know where the meter locations live geographically." Shaun describes this further, "In a perfect world, the WindMil model would be updated where all the meters are. If you move variables, the model is looking for the variables that are moving." Shaun and David have also added a feature whereby a percentage can be specified for the number of meters out in an area (set to any number like 90 percent), at which point the system would assume all the meters are out and move to the next asset. In other words, David explains "it might not be a protective device that is out, it might be a jumper instead of a cutoff or OCR." David also has an IT background and is a journeyman lineman. This electrical background has been an integral part of the GIS development team.

CMEC's GIS **interfaces with AMI**—CMEC envisions using the Trilliant AMI system to send outage notifications directly to the GIS based on confirmed meters offline. They plan to keep this interface simple and place "red dots on the screen depicting meters that are verified off-line, and then later integrate the predictive model."

By the end of 2018, CMEC also wants the ability to interact with meters from the GIS map. CMEC is currently exploring how to observe cutoffs for non-payment from the GIS map, since this is currently managed through the AMI. The advantage is that the GIS is available to every on-call lineman from home or their mobile device. Shaun's thoughts are "since the GIS web interface is so clear and requires less than 5 minutes of training, instead of searching the CIS for cutoff information, let the interface put a note automatically, so when

the on-call lineman zooms in to ping the meter, he sees there is a reason the member doesn't have power and it saves a trip to the office."

The AMI interface has been tested on historical data. Several months ago, CMEC ran a report from AMI that showed 3,000 meters out of power during a 5-minute interval. When the meters were pulled into the GIS, it was easy to conclude based on the geographic location of the meters, that it was not a CMEC breaker, but the power supplier. Knowing where the 3,000 meters were geographically located allowed CMEC to determine that it was a transmission issue, not a CMEC feeder breaker or CMEC substation. This type of information is invaluable.

CMEC using the AMI interfaced with their GIS has provided invaluable information to discern outages from transmission issues versus feeder breaker or substation issues.

Integration from CMEC's **GIS to Milsoft's WindMil Engineering Analysis software** will be a logical next step, but not a high priority for CMEC, because their system model does not change from year to year as one might expect from a co-op with steady growth. However, Shaun anticipates using **PostgreSQL and Multispeak** to export data, as needed for their engineering model.

When asked about **GIS and SCADA**, CMEC currently has an old SCADA system that probably needs to be updated in the future. David explains, "With our recently acquired knowledge of MultiSpeak, if new SCADA equipment is added in the future, we will make sure it meets MultiSpeak standards." They see value in getting "READ ONLY" readings from SCADA through a hyperlink into the GIS. David's opinion is that "other than SCADA for control, the line between SCADA and AMI is getting thinner as days go by. It's just as important to know what's at the end of the line as what the regulator reads."

Although the web map is live on the GIS web server, changes to the GIS can only be made from the GIS team.

## Limitations Today

From a business perspective, there are checks and security audits and patches for open source software, like what you purchase from collaborative software engineers from other GIS companies. One of the advantages of using commercially sold software is that any GIS professional can be trained to use it without a programming or IT background, and commercial tools tend to have more paid support and training options. CMEC understands the risk, but has worked diligently on documentation for the GIS and has not altered any of the open source software SOURCE CODE. One could argue that the open source software used by CMEC was created and developed over more time than many of the GIS software programs available to the electrical co-ops today.

Although the web map is live on the GIS web server, changes to the GIS can only be made from the GIS team. The typical workflow to update the maps is from a manually drawn staking sheet. Once the updates are made in the GIS, these are tested locally for integrity, and then pushed to the web server. At this point, for quality control, CMEC Management does not want anyone else editing the map. CMEC plans to eventually automate staking sheets, and they are currently discussing work flows and processes. They may use a software provider for staking. They have not explored open source software for this yet, but are aware that many staking software vendors are using open source software to develop.

There is also moderate concern about using satellite imagery to place GIS assets on the existing maps, because of the frequency of the satellite imagery updates. Very few companies update more than once every three years, so CMEC uses GPS equipment for new construction. When asked about the accuracy of the GIS map without sub-meter or more precise GPS equipment, Shaun estimates that assets could be off by as much as ten feet, "but it's more important to have the ability to search for a pole or transformer in the GIS, on the correct side of the road, on the same map you use to direct you to a specific address."

## Future Applications

Many co-ops are using open source software like Apache OpenOffice, in lieu of Microsoft Office. After a series of informal interviews and email communications in first quarter of 2018 with over 20 cooperatives, the author found that 80 percent of co-ops said their organization's use of open source software increased in the past year.

With any software, it is important to deploy it in testing environments prior to making purchases.

With any software, it is important to deploy it in testing environments prior to making purchases, to reduce the risk that co-ops can't afford to allow into their network environment.

CMEC has been losing members over time. To combat the loss in kWh sales, the co-op plans to expand its services to neighboring municipals or communities to include water, sewer, and gas GIS mapping. Using open source software, CMEC is not limited to electrical facility mapping. They can provide one GIS that includes everything a municipal might need in one map. Many municipals own other utilities, so this capability could be extremely beneficial.

In addition, CMEC has created licensing agreements, so that other co-ops can adopt the software and either develop it for themselves or work in tandem with Coles-Moultrie for future development. Sharing resources among co-ops has many advantages. Adding a GIS is not only an investment in hardware and software, it is also an investment in additional manpower including GIS professionals, staking technicians, training, and equipment. Many co-ops are offering services to reduce general and administrative expenses (G&A), or because they may not have enough work to dedicate personnel.

What is unique about CMEC's GIS is that it is very easy to use. Shaun is confident that within 5 minutes and a quick demonstration, any user is comfortable. When asked what project is too large, Shaun describes the process is the same, "Imagine you hire a contractor to build a house, you can build whatever you want. Having too much work is a good problem to have. With the lessons learned so far, the hard part is behind us." ■

## ADDITIONAL RESOURCES

- Shaun Vester (Manager of GIS Systems) **svester@cmec.coop**
- Jim Wallace (Director of Operations & Engineering) **jwallace@cmec.coop**
- For additional information about Coles-Moultrie Electric Cooperative's Avian Protection Plan **www.cmec.coop** Phone #: 217-235-0341 or 888-661-2632

## ABOUT THE AUTHOR

**Deborah Fish, PE**

Deborah is currently the President of Utility Resources, Inc., a consulting firm in North Carolina. She has worked with cooperatives across the country for 27 years. She also served as a Senior Program Manager for NRECA for the Distribution Operations Best Practices Member Advisory Group. Deborah has produced several reports for CRN on MultiSpeak and GIS along with various Business & Technology Surveillance studies. Contact Deborah at **deborah@utilityresources.net**.

## QUESTIONS OR COMMENTS

- David Pinney, Program Manager Analytics, NRECA Business and Technology Strategies, **David.Pinney@nreca.coop**
- Robbin Christianson, Senior Product Strategy Manager, NRECA Business and Technology Strategies, **Robbin.Christianson@nreca.coop**
- To find more resources on business and technology issues for cooperatives, visit our **website**.

## ANALYTICS, RESILIENCY AND RELIABILITY WORKGROUP

The Analytics, Resiliency and Reliability (ARR) Work Group, part of NRECA's Business and Technology Strategies department, is focused on on current and future data and research required to provide prompt technical and economic support to the NRECA membership. Specifically focused toward the electric co-op community, ARR products and services include: development and maintenance of a portfolio of energy analytics products and services; collection and analysis of data; and provision of additional products and services in the areas of the data collection, IT architecture, sensors, and energy markets. For more information, please visit **www.cooperative.com**, and for the current work by the Business and Technology Strategies department of NRECA, please see our **Portfolio**.