Business & Technology Surveillance

The Impact of Drone Technology on Rural Electric Cooperatives

By Shannon ("Shan") Knudsen, Growth by Design LLC

JUNE 2023

NRECA
America's Electric Cooperatives

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SUBJECT MATTER EXPERT ON THIS TOPIC

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

ARTICLE SNAPSHOT

WHAT HAS CHANGED WITH UTILITY DRONE USAGE?

Drone technology has advanced rapidly in recent years, generally making it more affordable and accessible for electric utilities. As a result, utility drone usage has increased significantly. This is due to a number of factors, including:

- The increasing affordability of drones.
- The development of more advanced drone technology, such as thermal imaging and LIDAR.
- The relaxation of FAA regulations governing the use of drones for commercial purposes.

WHAT IS THE IMPACT ON ELECTRIC COOPERATIVES?

Also referred to as Uncrewed Aerial Systems (UAS) or Uncrewed Aerial Vehicles (UAVs), drones are helping some co-ops to improve the safety, efficiency, and cost-effectiveness of their operations, and they are also helping co-ops to provide better service to their members.

Some of the specific ways in which drones are benefiting co-ops include:

- **Asset inspection:** Drones can be used to inspect power lines, substations, and other infrastructure from a safe distance. This can help co-ops to identify potential problems before they cause outages or other disruptions.
- **Vegetation management:** Drones can be used to collect data on vegetation growth, which can help co-ops with their vegetation management programs and, in turn, help reduce outages and other disruptions, which may then save the co-ops money on repairs and customer service costs.
- **Marketing and outreach:** Drones can be used to create aerial videos and photos of co-op facilities and service areas. This can be used to improve member engagement.

This article explores how some electric cooperatives are using new drone technology, as well as other emerging technologies, to help enable more efficient, economical, and safer operations.

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WHAT ARE SOME CONSIDERATIONS TO USING DRONES?

Some considerations for electric co-ops about using drones include:

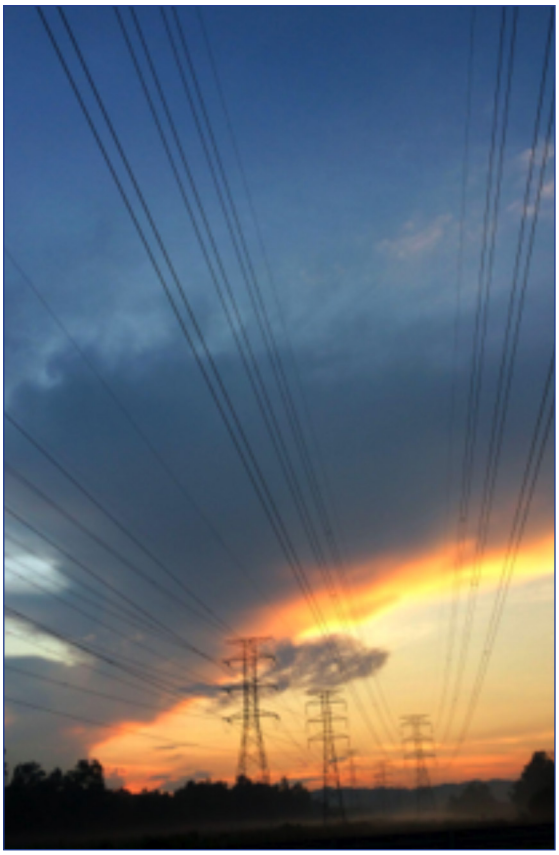
- The FAA regulations governing the use of drones for commercial purposes.
- The evolving technology options available.
- Upcoming federal funding opportunities for developing drone programs.

Introduction

Early use of drones in the energy sector focused on aerial inspections of wind turbines and solar panels using basic camera technology. As drone technology improved, they became capable of more sophisticated tasks, such as thermal imaging, LIDAR (Light Detection and Ranging), and other sensing capabilities. Drones are now used for a variety of tasks, including outage restoration; preventative inspection of power lines, transmission towers, and pipelines; conducting environmental surveys; and monitoring wildlife. Recent developments in drone technology include the use of artificial intelligence and machine learning algorithms, enabling drones to help detect and analyze issues in real-time, reducing the need for human intervention.

Rural electric cooperatives provide power to 56% of the nation's land mass and serve over 42 million people.[1] Because they provide services in remote areas with low population densities,[2] the risks of operating drones are generally lower, and thus, it is generally easier to obtain the necessary approvals for drone-related research, development, and commercial operations. This makes co-ops good candidates to consider early evaluation and adoption of useful drone technology. Further, because co-ops often cover rugged terrain with lower accessibility for traditional modes of transportation, the incentive is generally greater to find alternative means for inspection, grid maintenance, and supply chain logistics that can operate in the absence of roads and infrastructure. Drones afford many advantages in regard to their operational flexibility, not to mention, they are often significantly more economical to operate than their traditionally piloted counterparts and can be used for dangerous missions while helping to mitigate risk to worker health and safety. This article explores how some co-ops are using new drone technology, as well as other emerging technologies, to help enable more efficient, economical, and safer operations.

As of 2021, approximately 300 co-ops are using some form of drone technology in their operations.[3] Research for this article shows that the primary uses are for outage restoration, inspection and preventive



maintenance, or grid hardening. Such applications may be beneficial in many ways. The application of drone technologies can generally:

- Help enable cooperatives to **reduce outage time** through more effective response planning. Crews are able to review visual and other data prior to arriving at the outage site.
- **Improve reliability and resilience** through routine inspection and maintenance processes. Capturing high resolution images allows cooperatives to proactively identify potential concerns.
- **Address worker safety** by providing visual data to field workers, instead of manual inspection methods.
- **Reduce costs** that are ultimately passed along as savings to members by capturing high quality images and video, giving cooperatives quick overview and evaluation of infrastructure conditions. Drones can inspect power lines faster with an average speed of 40 MPH (65 km/h).

Drone Technology on the Market

As the demand for efficient and cost-effective solutions in the electrical industry grows, more and more co-ops are turning to drone technology to help improve their operations, but that does not mean that all drone technology meets their unique needs. For instance, high image quality can enable more effective assessment of utility infrastructure. However, not all drone models have been able to provide sufficiently high quality images, but advances are being made with respect to this aspect of drone technology.

LIDAR

LIDAR technology, which stands for *Light Detection and Ranging*, is one of the more popular and evolving technologies currently utilized by electric utilities. LIDAR imaging is a technology that uses lasers to measure distance and create precise three-dimensional maps of terrain and objects. When applied to drones, LIDAR allows the drone to generate a highly accurate and detailed 3D model of the surrounding environment by rapidly emitting and receiving laser pulses as it flies. It enables quick and efficient resampling of regions, offers high accuracy and point density, and covers vast areas. These features enable operators to produce results quickly, consistently, and accurately, all while detecting small changes at a high resolution.

This technology is particularly useful for mapping, surveying, and creating digital models of terrain, buildings, and other physical features. LIDAR offers unparalleled accuracy and reliability, making it a cost-effective means of gathering pole information over large electricity distribution areas. LIDAR technology can also help identify potential problems, such as vegetation growth or damaged power lines, that are not easily visible to the naked eye.

One example of how LIDAR is used by utilities beyond vegetation management and tracking is for determining line sag. Clearances for electric lines may be prescribed by law or regulations depending on the cooperative's size and the type and location of the line. Line sag may impact that analysis. LIDAR is excellent for gathering data for determining sag, as the 3D models that LIDAR

systems generate can be used for measurements. Cooperatives can define a minimum and a maxiumum for the conductors' height above ground, and then the software will automatically highlight in red anywhere there is a violation.

Examples of Current Drone Vendors

As the drone industry evolves, there are a variety of vendors offering technologies and solutions that have the potential to benefit co-op operations. The following section highlights a few on the market today. This list is not exhaustive and NRECA does not endorse or recommend any specific vendor. The comments and opinions included below may or may not be consistent with NRECA's. Co-ops that are interested in incorporating drones into their operations should conduct their own due diligence, which may include evaluating various vendor offerings and technologies to determine which best meets their unique circumstances and needs.

Rock Robotic offers a product suite that enables companies to have both in air as well as on the ground ability to capture and transmit LIDAR data. Rock Robotic also provides several options as it relates to the storing, transmitting and analysis of the data captured. Further, the data software is compatible with any LIDAR technology.

Phoenix LIDAR Systems (PLS) is another vendor that is compatible with drones. Phil Johnston of Fenris Electric Systems has recently begun using PLS's multi-platform system and pointed out two features:

1. The Phoenix LIDAR Ultra Ranger… *"is small enough to be carried on a drone, but powerful and accurate enough to also be carried on a manned helicopter. This gives great flexibility, as you can now go after smaller, quick-turn jobs with a drone. If you ever need to complete a long-distance LIDAR job, you can simply work with a helicopter aerial services company, mount up the Ultra Ranger, and go acquire huge amounts of data very quickly."*
2. *"PLS has a special capability that is focused on capturing vertical faces, such as transmission and distribution structures. It has a 10 degree forward "sweep," a directly downward "sweep," and a 10 degree backward "sweep." This helps put points on those vertical faces that would otherwise be difficult to get data on."*

Other LIDAR providers include Velodyne LIDAR, Inc. (US), RIEGL Laser Measurement Systems GmbH (Austria), Teledyne Optech Inc. (Canada), Microdrones (Germany), YellowScan (France), UMS Skeldar (Switzerland), LIDARUSA (US), SICK AG (Germany), and GeoCue Group (US).[4]

Drone Hardware, Foreign and Domestic

Drones offer many other useful tools for co-ops beyond LIDAR. A variety of newcomers and cutting-edge drone technologies are making waves in the drone ecosystem, which is extremely innovative. While there are simply too many vendors and products to cover in one article, here are a few examples that may be relevant to co-ops at this time: Watts Innovations, Freefly Systems, Skydio, DJI, Percepto, and Buzz Solutions.

WATTS INNOVATIONS

Prism by **Watts Innovations** (Watts) is 100% based in the United States. In 2021, they scaled their production for their PRISM business to meet the demand amongst customers across several different sectors. The PRISM drone is able to be flown as a quadcopter or an X8 Coaxial. When flown as a Coaxial, the aircraft has a payload up to 25 pounds (vs. 5 pounds as a quadcopter), without sacrificing flight time or speed. The PRISM can be equipped with a variety of hardware (video, LIDAR, Survey and Mapping tools, spray, and cargo carry). In 2022, the company went on to launch their PRISM Sky, Kontact GCS, and REEL Intelligent Delivery Winch. PRISM Sky gives operators all of the benefits of the traditional PRISM aircraft, but has the addition of the Kontact Ground Control technology and is powered by Auterion's Skynode. This partnership enables the aircraft with LTE technology that allows operators to view video and upload flight logs in real time.[5]

FREEFLY SYSTEMS

Freefly Systems is a USA company and its drones undergo testing to ensure quality control, are rugged by design, and have been used for demanding applications. The Freefly Alta X is portable, folding down to half its size, and ready to fly in under two minutes.[6,7,8] The Alta X was chosen to replace the DJI Matrice 600 by **Drone Amplified**, pioneer "of the only UAS-based aerial ignitions payload available to the U.S. market that is approved for use on Federal prescribed fires and wildfires." The switch was motivated in 2020 by the grounding of all the U.S. Department of the Interior's drone fleet that were made by or included Chinese parts, including the DJI models.[9]

The Freefly Astro is a lightweight version that comes with an open architecture 3-axis gimbal that may be adapted to new payloads.[10]

SKYDIO

Skydio, another U.S. based company, founded in 2014, created a UAS system that has become broadly known in the energy sector as it relates to the inspection process. All Skydio drones are equipped with six 4K cameras, but they also offer navigation systems that are not impacted by EMI (electromagnetic interference). According to the company, this allows for Operation

and Management teams to get much closer to the assets they are inspecting, with the ability to map out their surroundings with acute accuracy. According to the Skydio website, the company recently announced the Skydio Dock and Skydio Docklite. These docks, paired with the Skydio Remote Ops software, will allow customers the ability to operate their drones remotely. In 2022, the Federal Aviation Administration (FAA) granted Dominion Energy a pivotal approval to fly Skydio drones beyond visual line of sight (BVLOS) to inspect power generation.[11] Additionally, Skydio launched Regulatory Services that are assisting the clients with gaining approval for operating BVLOS, even in fully remote scenarios. This functionality may help co-ops establish or advance their drone programs.

DJI

DJI provides a range of drone products and services. They offer several models that are suitable for utility inspections, including the Matrice series, which can carry a range of payloads, such as thermal and multispectral sensors.

DJI is the leading drone provider in the world with over 70% of global market share.[12] However with states like Florida now banning the use of DJI and other Chinese-made drones by local government and law enforcement agencies, and other states poised to follow suit,[13] there is potential risk when procuring or continuing to rely upon a specific drone technology that could be banned in other states or by the federal government. This consideration is especially salient for co-ops because the power grid is considered critical infrastructure and garners attention from lawmakers and regulators. There are legislative inquiries and bills currently in process, such as the American Security Drone Act of 2023, that are investigating the alleged threat posed by Chinese-made drones, which may result in broader restrictions on use of certain drones.[14, 15]

Despite the potential headwinds faced by DJI, the company has a strong customer base in the U.S., especially among U.S. public safety agencies, for which DJI owns more than 90% of the market share.[16] DJI may remain popular due to its products costing at least 2x less than any American made drones. DJI products that may be specifically useful to co-op operations include:

1. Zenmuse L1 with Livox LIDAR module with Matrice 300 RTK[17]
2. DJI Zenmuse H20T payload for M300[18]
3. DJI Matrice M210 RTK FLIR Thermal Imaging Kit[19]

Data Processing

When it comes to inspection and maintenance, real time monitoring and visualization are beneficial, however that is not where the process ends. After drones capture visuals of infrastructure, the ability to organize and analyze all the data is needed to make preventive maintenance decisions that can help reduce costly outages. This brings us to the companies that are offering artificial intelligence and machine learning (AI/ML) products.

PERCEPTO

Percepto is a company that some utility companies are turning to for their comprehensive autonomous inspection and monitoring software (AIM). The popular "drone in a box," as it is often called, allows utility companies to routinely capture high quality visual and thermal images of their infrastructure. The AIM solution provides data accessibility, as well as regulatory compliance monitoring to assist with compliance by making data available to demonstrate at any time. Percepto made headlines as the recipient of Canada's first approval for BVLOS operations without a visual observer on site.[20] Percepto received similar approval in America from the FAA for BVLOS operations without a visual observer onsite.The FAA approval is a blanket approval for the company's operations, so Percepto need not apply for it with each customer.[21]

BUZZ SOLUTIONS

Buzz Solutions is a startup that uses AI and machine vision technology to analyze images of power lines and towers from drones, helicopters, and aircraft to find faults, flaws, and overgrown vegetation in and around the grid infrastructure. Buzz Solutions provides an end-to-end solution for cost- and time-efficient visual data management, processing,

and analytics. They offer a software platform, called PowerAI, used for detecting anomalies, managing vegetation, and providing actionable insights during infrastructure inspections. Their technology can help T&D network operators in reducing failures, outages, and wildfires. According to their website, Buzz Solutions can do the analysis at half the cost and in a fraction of the time compared to humans. Buzz Solutions has pilots in the works with major utilities across the country, and has raised $1.2 million to perform image analysis and provide actionable reports in a matter of hours or days, compared to the six to eight months it takes utilities now when the work is performed by engineers.[22, 23]

Emerging Technology for Co-ops just over the Horizon

The new tech being utilized by the power grid industry is quite fascinating, however it is equally intriguing to peer just over the horizon at emerging technology that is coming online soon and try to imagine how it may be used to benefit co-ops. There are generally recognized constraints for current drone technology that tend to limit its utility for co-ops. For example, technical limitations include how much weight a drone can carry, how long a drone can fly with its maximum payload, and how far and under what weather conditions a drone pilot can maintain connectivity with its drone in order to successfully control it.[24] Improvements in all these areas may enable the expansion of drone utility and application for co-ops. Not surprisingly, there are companies making significant headway in expanding the technical capabilities of drones.

FLYX TECHNOLOGIES

One such example is **FlyX Technologies**. Founded in 2020 and headquartered in Bellevue, Washington, FlyX Technologies is a hi-tech startup developing a Revolutionary Wireless Power Transfer (WPT) Charging Technology "to enable unlimited flight range and Beyond Visual Line of Sight flight capability for Drones to unlock Limitless Possibilities/Applications," according to founder and CEO, Farzad Rahbar.

FlyX Technologies has developed a proprietary ultra-low frequency wireless power charging technology from distribution and transmission lines, which is capable of powering small drones. By improving battery capacity and flight duration capabilities for smaller drones, it enables larger reach for drone-assisted grid inspection and mapping.

So, how does it work? A FlyX drone inspects power lines until its battery reaches a pre-set level, triggering a wireless charging procedure. The drone uses sensors to align with the powerline and lands on it in hover mode. The Wireless Power Charging mechanism then inductively charges the drone battery at 50 to 60 Hz while the drone is in idle mode. Once the battery is charged, the drone lifts off and continues its inspection. This process can repeat infinitely, providing unlimited flight range for the drone within the operational limitations. "Essentially, we are creating an aerial mobile platform that can be equipped with a variety of sensors—optical, thermal, laser, etc.—capable of collecting vast amounts of data while reducing operation costs by an order of magnitude," added Farzad. The end goal is providing a more efficient tool for improving grid reliability and resilience.

Like most autonomous systems, FlyX also aims to reduce risk and improve safety for personnel (linemen and helicopter pilots), performing dangerous duties by providing a safer alternative to traditional hands-on inspection methods. According to Farzad, FlyX's vision is to build autonomous flying drones that are less than 2 lb/1 kg and capable of flying BVLOS. Its proprietary WPT can be used to power larger drones, however, FlyX and utility customers have agreed that smaller drone platforms are desired because they are nimble, light, and pose less risk to the infrastructure and property they will be inspecting in close proximity. FlyX has designed and built a prototype of their WPT and drone prototype, and they have filed a U.S. patent with the U.S. Patent and Trademark Office (USPTO) for their innovation.

FlyX is encouraged by the enthusiastic engagement of stakeholders in the power line industry to date, and hopes to continue

experimental collaboration with potentially interested customers, including co-ops. "Our drone equipped with WPT is ready to be tested in the field with co-op members for evaluation, so that they can experience the technology first-hand. I'd like to hear from co-op members about their main pain points, so that we can focus our efforts on what matters most to potential co-op end-users," concluded Farzad.

PARALLEL FLIGHT TECHNOLOGIES

Parallel Flight Technologies (PFT) is another company that aims to expand the utility of drones with its flagship heavy-lift UAS platform, Firefly. According to its StartEngine Reg CF offering page,[25] PFT's "transformative Parallel Hybrid propulsion technology" enables drones to carry heavy payloads exponentially longer than current competitors, can achieve 90% carbon footprint reduction, and can save 50% - 75% on operating costs compared to helicopters. Based on PFT's latest specification sheet, Firefly anticipates carrying payloads of 100 lb up to 90 miles, 50 lb up to 210 miles, and lower payloads for close to 300 miles. For a wingless quadcopter that weighs about 130 lb empty and stands a meter off the ground, this can mean gains in flight duration and range of up to 10X compared to commercially available all-electric drones of similar size and configuration, according to PFT promotional materials.

When asked how PFT could potentially benefit the power grid industry, CEO and cofounder Joshua Resnick had this to say:

> *"We envision the extension of flight duration and range with heavy payloads as a game-changer for many operations related to co-ops and the industry at large. We've been approached by companies about using our tech to replace helicopters for power line stringing in order to reduce costs and improve safety, however, we believe the use cases are much broader. In fact, for payloads up to 100 lb, and even up to 500 lb with larger drones we've begun designing, if helicopters are currently performing an operation, we anticipate being able to perform many of the same operations at 1/10th the cost of the traditional alternative, and without the risk to pilots."*

Resnick went on to point out that Parallel Flight's drones can fly in smoke, fog, and other degraded visual environments when traditional aircraft are typically grounded. This enables them to be used for emergency response and disaster relief operations, including in dangerous conditions that would generally subject traditional pilots to increased risk.

PFT was founded in 2018 to develop a heavy lift autonomous solution to support wildfire mitigation and firefighters on the front lines. In collaboration with the U.S. Forest Service and other public and private stakeholders, PFT has been developing expanded aerial ignition and tactical resupply capabilities for personnel performing operations in remote, austere environments where supply chain logistics are challenging. The ability to stage equipment and resupply utility workers in these same environments may benefit co-ops in the near future. The fact that Firefly can be refueled in the field and does not require battery swaps or heavy battery charging accessories is a preferred benefit of the U.S. Forest Service and other development partners like the Department of Defense.

While the author is not aware of co-ops currently using drones to carry equipment or other payloads at the high end of Firefly's capabilities, conceivably, as these larger systems mature and come down in cost, they could be used to carry equipment to linemen who are working on towers, especially in rugged/inaccessible terrain. This is normally done by helicopters, but large drones may be able to augment the helicopter operations and speed up the workflow, potentially lowering costs and increasing safety for more dangerous operations.

PFT's Firefly is still in the prototype phase and not yet currently available on the market, but, like FlyX, PFT is very interested in collaborating with co-ops and other electric utility stakeholders to explore potential benefits of the new technology.

An Interview with Phil Johnston

To get another take on considerations related to starting a drone program, the following is an interview with Phil Johnston, Vice President at Fenris Electric Systems, a drone services and consulting company. Phil's experience includes flying drones for larger public

electric utilities. Phil's comments and opinions may or may not be consistent with NRECA's.

Shan: Phil, please tell me a little more about your background and how you ended up consulting for co-ops and electric utilities?

Phil: I first worked in Engineering on military drone technology, then moved to manned, airborne surveillance systems. This helped me grow my flight test skills, and to really learn the world of sensors and how they work. From there, I ended up moving to Maryland to work at an electrical utility contractor that specializes in distribution and transmission construction, maintenance, and repair. I was creating and running the drone department there, so I flew for the company internally, helping with bidding and estimating, and I also flew electrical utility inspections for larger utilities and also for co-ops as a service. I saw many utilities and utility contractors were interested in integrating drones into their operations, but they were stymied by the vast amount of specialized knowledge required to get started. So when I went on my own, I decided to provide a consulting service focused on helping my customers launch their own drone program.

Shan: What are some of the coolest operations you've been able to pull off using drones? I like the one where you actually secured one drone to the belly of another drone in order to take advantage of the sensor on one and the flying capability of the other. Please tell us about that one.

Phil: I have actually completed 106 underground electrical vault inspections by drone. This is done by flying right down through the manhole! Flying in a confined space, out of visual line of sight underground, is quite tricky. My passion for flying FPV (First Person View), or piloting radio-controlled vehicles through a real-time wireless video link, has helped me develop the special skills required for this inspection profile. The sensor you mention was actually a DJI XT2 thermal and daylight sensor that I needed for the thermal inspection of the electrical splices. I needed this sensor as the confined space drone I was using for the visual inspection did not have a radiometric (able to measure temperature) thermal camera onboard. So, I took the propellers off of a DJI M210 drone and folded the arms in (to make the package physically more compact/smaller), mounted the XT2 thermal and daylight camera on the M210 drone as normal, and attached the whole drone to an inverted tripod, and lowered it into the manhole. This gave me the ability to complete the thermal inspection of the splices.

Shan: That's real ingenuity. So, tell me, one of the services you provide is consultation for electric utilities interested in developing drone programs. What guidance would you give to co-ops on the fence or about to take first steps?

Phil: The first step is to define what success looks like. What is the current need of the team? If it's first the ability to get a clear, overhead view of problems on structures, then a very simple drone can be used, without a lot of specialized technology training. I believe a crawl, walk, run approach to any highly complex problem is best. A co-op could first learn and understand the regulatory and law requirements of a drone program, including commercial drone pilot licenses and drone hull and operations insurance. Then from there, a co-op can begin to build out an Operations Manual, Training and Maintenance documentation, and other required program documentation. After that is complete, or the first drafts are ready, then a co-op can begin to look at hardware and software solutions. There are so many components of a successful drone program that I very much recommend a co-op work with an outside drone consulting company that specializes in the electric utility industry, such as Fenris Electric Systems, to get started. This will help avoid dangerous legal pitfalls, money pits, and failed programs.

Shan: Do you have some recommendations for co-ops who are just getting started with drone technology?

Phil: For those new to drones, it may be helpful to have a ready-to-go package, so they aren't trying to customize everything just to extract value. A couple of American

companies offering complete packages that I have been impressed with are **Watts Innovations** and **Freefly Systems**. Both have demonstrated extremely high-quality aircraft, highly integrated sensors and solutions, and continuing innovation. There are also a lot of useful DJI products on the market. However, we are seeing increasing regulatory pressure and outright bans across states and government agencies. For this reason, those just getting started with drones should be sure to understand the regulations in their area of the country before investing in a DJI or any other drone technology.

Shan: What are some of the challenges that co-ops should be prepared to face when developing a drone program?

Phil: The Federal Aviation Administration (the FAA) has extremely strict rules, laws, and regulations regarding flying drones in certain airspaces. This includes airports, prisons, stadiums, military sites, and so on. Training to understand this is absolutely critical. The required training for the FAA Part 107 Commercial Drone Pilot license will include much of this, but it does not go into detail on how to apply for waivers, for when you need to fly in these restricted airspaces in order to complete your inspections. There are also FAA mandated requirements for the drone program to track and log drone maintenance and pilot operations, along with other documentation. Many of the specialized sensors, such as thermal cameras and LIDAR sensors, absolutely require specific training to extract accurate data. The world of software, including the firmware inside the drones and controllers, batteries, chargers, and sensors, is always moving forward, so understanding how to maintain and manage that is also extremely important. Standard Operating Procedures (SOP) for how inspections are to be completed will also greatly enhance safety, efficiency, and speed of both data collection, and reporting. One of the biggest challenges anybody faces getting started using drones is the vast, bewildering array of both hardware and software options available. How to choose which is right for you? And then, the other equally difficult challenge, is how to actually use this technology. This is particularly difficult, as there are not many truly comprehensive training programs out there that start from scratch and help launch a complete drone program.

Considerations When Implementing a Drone Program

Co-ops that are interested in implementing a drone program may want to consider:

STARTUP COSTS

An initial challenge is startup cost. It is important that the drone and the program design are specific to the needs of each cooperative to maximize the value you are getting from the program. Startup costs would include not only the cost of the drone, but the supporting software/equipment, training, and insurance. Considerations for drone pilots include how to operate drones safely and effectively, understanding the capabilities and limitations of the drone, planning and executing flights, and handling emergency situations, among other things.

FAA REGULATIONS AND STATE LAWS

Drone operations require a certification from the Federal Aviation Administration (FAA) and complying with strict regulations, which include obtaining a remote pilot certificate, registering drones, and following airspace rules. Several companies, including some highlighted in this article, provide support when it comes to acquiring FAA certification. Concerns about privacy and security, varying state and local laws, and issues related to infrastructure and air traffic control, are additional considerations.

PROTOCOLS AND INTERNAL CONTROLS

Standard operating procedures are necessary for ensuring compliance with FAA requirements and other applicable regulations. These SOPs cover all aspects of the drone program, including flight planning, pre-flight inspections, flight operations, emergency procedures, and post-flight data analysis.

LEGAL AND INSURANCE CONSIDERATIONS

Electric cooperatives considering a drone program can work with the cooperative's insurer and the cooperative's attorney to better understand and address potential risks with operating drones including, but not limited to, potential risks of flying the drone itself, third party injury, property damage, cybersecurity, and worker's compensation.

Potential for Grant Funding

Co-ops looking to take advantage of adopting new drone technology, but not sure how to finance or fund the endeavor can consider exploring grant opportunities from the Department of Energy, as well as other federal, state, and private sources. The Department of Transportation's Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program awarded millions in FY 2022 to at least six projects to pilot the use of novel drone technology for infrastructure inspection and other applications. More recently, the Department of Energy's Smart Grid Grant program will invest up to $3 billion ($600 million/year for Fiscal Years 2022-2026) in grid resilience technologies and solutions[26] as part of the Grid Resilience and Innovation Partnerships (GRIP) Program.[27] It is likely that future rounds of funding will provide opportunities to support the implementation of new drone and related technologies to improve grid operations.

Co-ops Currently Utilizing Drones

Many co-ops are using drone technology for a variety of applications. Those with experience may be a helpful resource for others that are considering beginning drones programs. Co-ops are encouraged to share with each other their efforts and lessons learned, and to join NRECA's **Smart Grid and Data Consortium** for discussions on drones and other smart grid technologies.

A few co-op drone applications that have been mentioned in recent media coverage include:

- **Cuivre River Electric Cooperative**[28] implemented a program in 2022 for the inspection of their distribution lines.
- **Arkansas Valley Electric Cooperative** deployed their drone program in 2017 for transmission inspection purposes and outage response during and after storms.[29]
- **Midwest Energy Cooperative** uses drones for environmental monitoring, inspecting solar panels, and tracking wildlife around substations.[30]

Looking Forward

Emerging drone and ancillary technologies may have the potential to revolutionize the operations and maintenance of electric cooperatives, to help enhance their efficiency, reduce operational costs, and improve safety for their workers. Embracing these emerging technologies and investing in the necessary infrastructure and training may help electric cooperatives stay ahead of the curve and continue to provide reliable, affordable, and sustainable power to their members for years to come. However, it is generally important to approach these technologies methodically and with caution, to help ensure that they are implemented safely and successfully.

To assist co-ops in this journey, NRECA intends to more deeply explore co-ops that have initiated drone programs in future articles. This will incorporate experiences and considerations from individuals who have evaluated and utilized drone tech in operational environments to help inform cooperatives on the many aspects of drone program implementation. The goal is to share amongst this community technology examples and lessons learned, so that all can benefit from our collective experiences. ■

FOOTNOTES

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ABOUT THE AUTHOR

Shannon ("Shan") Knudsen is a grant and contract specialist focusing on cutting edge technology and helping nonprofits and early-stage tech startups navigate grant applications and non-dilutive funding. Having spent his formative years in the grant and contract departments of George Washington University and Northern Arizona University, Shan spent most of his early career helping academic innovators and research professionals secure funding from major sponsors to pursue innovation. Shan then left academia to advise and support startups and nonprofits, and most recently, has been assisting electric cooperatives with Department of Energy grant applications. A former Peace Corps Volunteer, Shan is currently a partner at Growth by Design LLC, has an MBA in International Finance from GWU, and is a Certified Research Administrator. He is also a member of NASA's Wildland Fire Industry Working Group.

QUESTIONS OR COMMENTS

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- 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**.