THE FUTURE

OF GRID INFRASTRUCTURE INTEGRITY

An ikeGPS Reader

FOREWORD

There's no one way to prepare for the future, but there's usually a better way than to keep doing what's being done today exactly the way we've been doing it for a while.

I should know.

I've been helping utilities find a better way to maintain and improve the integrity of the electric grid's infrastructure for the last thirty years.

Things were different in the early 1990s when I was beginning my career as an engineer in the utility industry. Utilities had widely adopted personal computers, but software and the Internet weren't then what they are now.

To paint the picture, Amazon.com was still a few years from being founded. Its creator, Jeff Bezos, still had hair. So did I for that matter, at least more of it-but we're getting off track.

Measuring the grid's infrastructure assets was a very manual and time-consuming exercise back then.

I was a young engineer, just barely out of college, when I wondered how computers could help speed up an otherwise long process that was, in the end, imprecise and therefore a potential liability for utilities solely responsible for complying with the National Electrical Safety Code regulations.

In the early 2000s, after years of working with the best minds in the utility industry and months of sitting alone in a room writing computer code, I had created software that offered a better way to prepare for the future of grid infrastructure integrity.

I called it...PoleForeman.

Today, PoleForeman is the industry standard for delivering utilities accurate, reliable, and defendable pole load analysis. If you're reading this, there is a good chance your organization already uses PoleForeman.

But the current explosion of broadband internet and the subsequent joint use attachment requests along with storm hardening requirements mean utilities bear an even greater burden to maintain grid infrastructure integrity now and in the future.

This book contains essays written by the experts at ikeGPS and aims to introduce the fundamentals needed for utilities, engineering organizations that work with utilities, and telecommunications companies to create a foundation to meet the future of grid infrastructure integrity.

Data is at the heart of that foundation.

More to the point, accurate data in all of its forms–whether acquired in the field or analyzed in software–is critical to achieving the kind of dependable and defendable infrastructure analysis that utilities need to achieve and maintain the integrity of the electric grid.

The calculations and work we do today will greatly impact how the grid performs tomorrow. It comes with the job. Always has.

We hope this book serves as a dependable resource for you no matter where you are in your journey to pursue grid infrastructure integrity.

And if you have any questions or want to learn more about how IKE's solutions and tools help maintain grid infrastructure integrity, give us a call or visit ikegps.com and contact us online.

Like the electric grid, our industry has come a long way over the last thirty years. And if we're going to find a better way to get us through the next thirty, our best bet is to do the one thing that never lets an engineer down...swap ideas.

Go ahead. Ike is listening.

-Malcolm Young

Malcolm Young is Senior Vice President of Structural Analysis at ikeGPS and founder of IKE PoleForeman

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Pole Audits 101

What is a Pole Audit?

Pole audit is the broad term used to cover the survey of utility poles in order to get information about the location of the pole, condition of the pole and the pole line hardware, inventory of equipment, joint cable attachment count, and other valuable information about a utility's grid infrastructure.

An audit can be as basic as making sure the pole is plumb or checking for pole grounds. It can also be as complex as running pole loading and clearance analysis.

Regardless of its level of complexity, the goal of a pole audit simple: **acquire the information needed to make efficient and accurate decisions about your poles with data from the audit.**

Types of Pole Audits

There are several types of pole audits a utility might choose to conduct, including:

Inventory

An image-based inventory of poles and equipment used for decision making about pole condition, lifespan, and location.

Joint Use

An audit used to determine the state of third-party attachments on a network. This type of audit can be used for joint use billing, identifying illegal attaches, and verifying existing attachments.

Post Construction

An audit performed specifically to verify that poles or equipment were installed or constructed correctly per engineering work order, company construction standards, and governing safety code (NESC, GO-95, CSA).

GroundLine Inspection

Identify pole deterioration due to shell or internal rot to determine if a pole should remain in service, be reinforced, or be replaced.

Guy

Verify the presence of guy markers where required and proper placement of guy strain insulators and guy grounding.

NESC

Identify compliance with NESC for mid-span clearance, communication worker safety zone clearance, guying, pole loading, grounding, etc.

Why do we audit utility poles?

Since the Industrial Revolution, wood utility and telephone poles have been used as the scaffolding on which North America has developed its electricity and communications infrastructure. The life expectancy of these poles is generally thought to be between 40 and 70 years.

The pole auditing process checks everything associated with the utility pole and ensures the poles have been built per the design specifications. Poles built per design can be better expected to reach their estimated life span and ensure public safety throughout its service.

The advancement in the field of communication technology and the high expense involved with the construction of underground cables have increased the need to attach various cables (CATV, fiber, 5G, etc) to existing poles.

Cleveland, Ohio after the Great Lakes Storm of 1913. Public Domain

The additional loading in the pole caused by an increase in the cable count will potentially warrant the replacement of the pole. As pole replacement could also be an expensive process, the attaching company may choose to attach to the pole without proper permits. The process of pole auditing can help the pole owners become aware of illegal joint use and take necessary steps to prevent pole failures.

Additionally, pole audits can flag the poles not built per design. The engineers can re-run the pole loading analysis to ensure that existing poles comply with the National Electric Safety Code (NESC) requirements. The process can likely prevent the failure of poles while also saving its owner a potential lawsuit.

What are the consequences of not auditing?

Regardless of their good intentions, pole owners' ignorance about poles in their distribution grids and failure to replace overstressed poles could possibly cost them millions of dollars in revenue as a result of pole failure and illegal attachment.

At their worst, the ill effects of not knowing the details of poles within a utility's grid infrastructure go far beyond finance. Attachments add up. Poles get old. Location data can be lost. And full inspection does not happen without knowing what's there to begin with.

Wildfires in California and deep freezes in Texas are only the most recent extreme examples of how a lack of knowledge that could have been gained from audits and inspections leads to a compromised infrastructure that results in the failure to deliver electricity to the people in times of need.

No one will say these outcomes are acceptable, but even utility executives have said the lofty cost to make the system perfect is not in anyone's interest.
We have to start somewhere though. In the pursuit of a more perfect system, pole audits sit at the start.

Inefficient pole audits cost real money.

If pole audits mark the beginning of a better system, why are they not performed regularly? The answer is largely due to both the labor costs associated with sending manpower to the field and the confidence (or lack thereof) in the reliability and usefulness of the data the teams in the field collected.

Common problems with traditional pole audits include the inability to organize big data sets. Trying to merge audit data from multiple field teams into one spreadsheet is a tedious process that is prone to errors.

Additionally, the field-acquired photographs of the poles present another level of complexity. Typically, pole audits involve large amounts of data so it is extremely important to organize, manage, and process data efficiently to reap the full benefits of the audit.

Another common problem with traditional pole audits is the lack of instructions defining the scope of the audit. For example, the term "NESC audit" is commonly found in pole audit requests for proposals (RFPs). There is, however, no clear scope or guidance as to what rule or rules in the NESC need to be checked.

It is neither practical nor feasible to expect a pole audit to cover every rule within the NESC. The lack of scope definition results in pole owners believing "NESC Audit" checks for compliance with all NESC rules. Pole owners should clearly define, scope out, and explain what is expected from the audit.

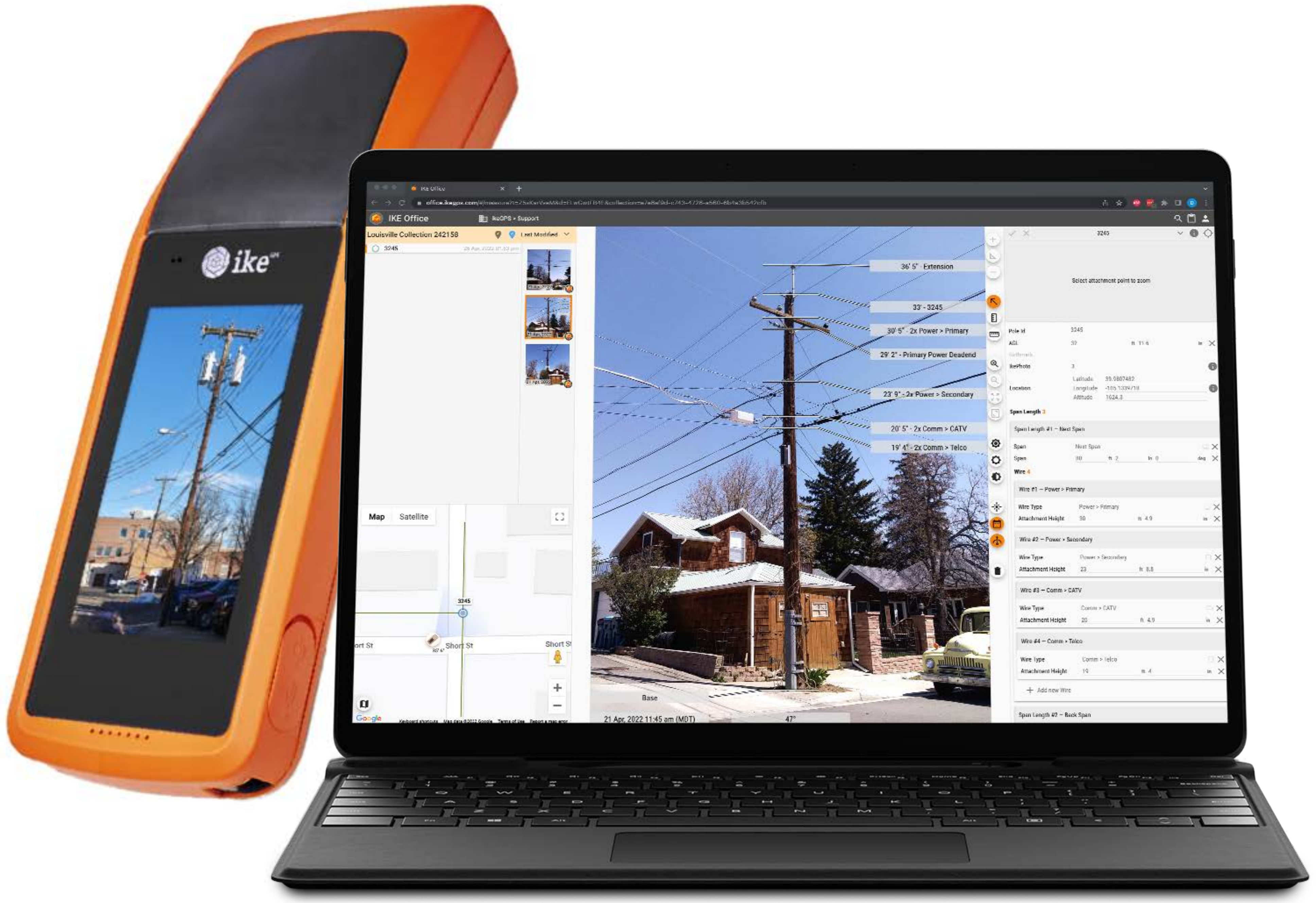
The lack of clarity manifested in traditional methods and applications of pole audits has long created a level of complexity that has made it difficult for pole owners and their contractors to lift the veil of ignorance about their distribution grids and grid infrastructure. In the last decade, however, modern methods for performing these audits have begun to be adopted, helping to streamline and simplify the audit process.

How are modern audits performed?

Modern pole audits use advanced, cloud-based technology platforms that include mobile field data collection units, GPS, laser, and cameras. These platforms allow field data collection teams to map out their routes, set daily pole acquisition goals, and upload data in real-time.

The people back at the office then immediately check the quality of the field data collection while processing data with a team of experts. The modern audit process is designed to be efficient, fast, and effective in addressing the limiting factors that plagued traditional audits.

Today and heading into the future, the introduction of artificial intelligence (A.I.) creates an entirely new set of opportunities through data science and feature extraction. And while the promise of A.I. presents a massive opportunity for maintaining grid infrastructure integrity tomorrow, the modern cloud solution in use today will still serve as the foundation.



IKE Device and IKE Office Pro

Here's what a cloud-based pole audit solution offers your business.

Faster field data collection

Often, the biggest expense of a pole audit from a labor standpoint is the time and cost associated with collecting the data in the field then transferring it to a computer for analysis and storage. Cloud-based pole audit technology speeds up your field teams and gets the data right into your system without any transcription errors or pole revisits.

In the cloud, your data stays organized and readily available for access from anywhere.

Detailed information about attachers and status

Cloud-based software brings all your audit data together and lets you draw unique insights about who is attaching to your poles and whether they are compliant. You can look at broad data trends or at individual poles and attachments as needed. Additionally, these reports can be used to check additional NESC rules that may not have been in the original scope of the audit.

Visual pole condition reports

Visual pole condition reports are stored in the cloud, allowing multiple stakeholders to verify pole conditions without ever leaving the office.

Data portability and permanence

Cloud-hosted pole data is readily available to be used in any other format. From permitting, to pole loading, moving data can be as simple as a few clicks. Additionally, cloud-based data ensures your data is safe from deletion or loss due to local file management issues and benefits from the added security of tested cloud infrastructure.

Inspection-ready work plans

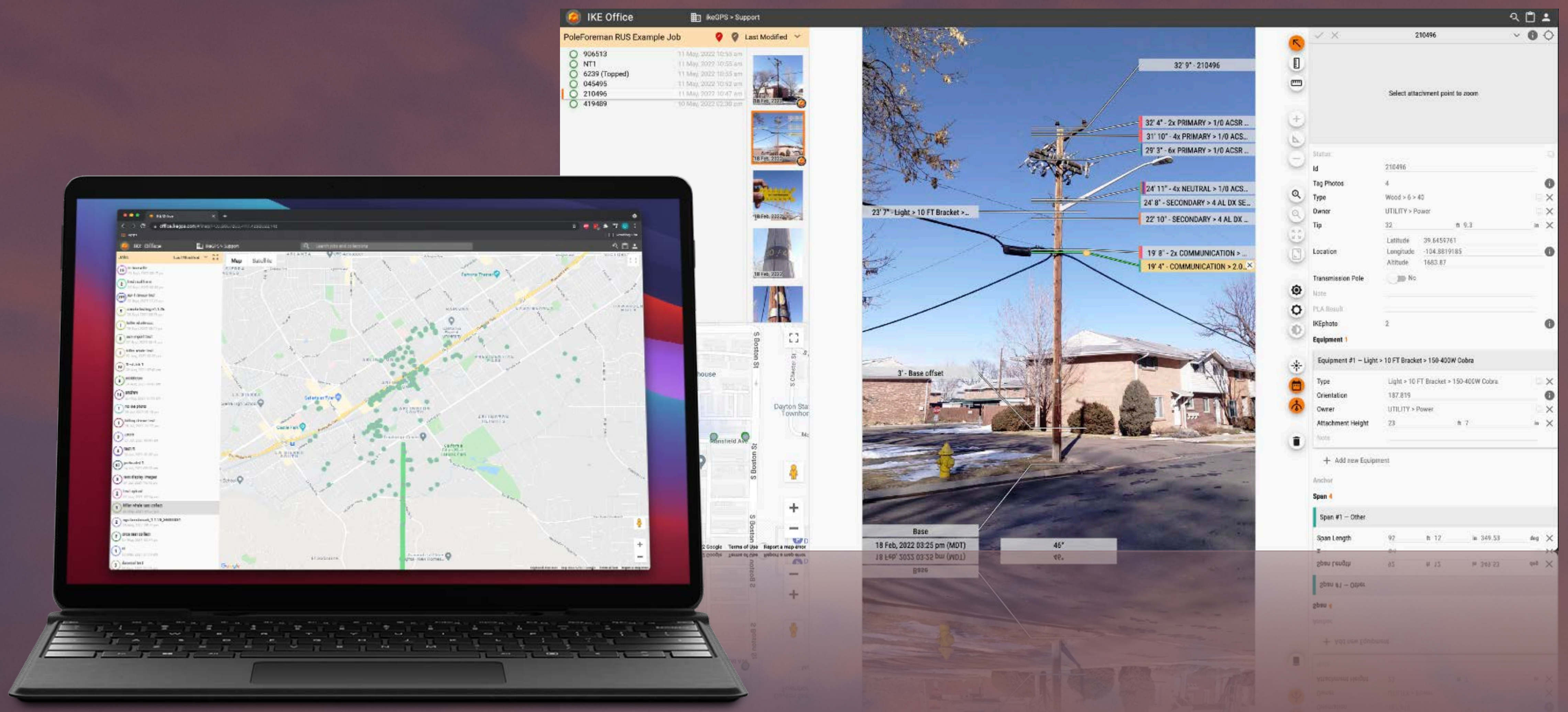
Create routes for full inspections with pre-populated locations and photos. Your inspection teams can follow logical, location-based work plans to increase the efficiency of a full inspection and decrease cost.

Standardize Your Grid Infrastructure Data... Like a *Pro.*

IKE Office Pro is a cloud-based software platform that takes the data acquired in the field with the IKE Device and creates a standardized digital twin of pole records that, if desired, can integrate with the leading third-party structural analysis, asset management and GIS tools such as Alden, NJUNS, PoleForeman, O-calc, SPIDAcalc, Quick Pole & Esri.

- **Measure every aspect of the grid infrastructure.**
- **Track analysis projects in real time with custom-built dashboards.**
- **Export data to native formats of the most used systems in the industry.**

With IKE Office Pro, you have an elite software tool designed to help you build the grid infrastructure records you need...quickly and efficiently.



See
IKE Office Pro
in Action.

Watch Video

ike GPS

How Accurate Pole Load Analysis Creates System Resiliency

The power distribution system plays an essential role in our modern society.

Hanging on the backs of **hundreds of millions of utility poles**, it delivers electric power, the driving force of life in the 21st century, to homes and businesses around the world.

Yet because of the pole-based nature of its construction, the grid infrastructure that serves as the physical framework for the power distribution system is vulnerable to natural disasters and calamities such as tornadoes and hurricanes. These **natural calamities and changes in climatic conditions have huge effects on the distribution grid** and the thousands that depend on the power it supplies.

Pole owners need to analyze their network to create system resiliency to combat the damaging effects of nature and build a stronger distribution grid.

What is System Resiliency?

The distribution grid is designed as a self-protecting system composed of protective devices throughout the grid to isolate faults.

Simply put, a fault created anywhere on the feeder, such as that of a pole failure, will cause power outages from the first upstream protective device to the end of the circuit. For example, just one pole failure on a mainline feeder can knock out power to neighborhoods, businesses, and entire communities.

To minimize the frequency of power outages, power companies strive to ensure their distribution grid is resilient against extreme weather-related events.

The term "system resiliency" is used to describe how well the utility poles making up the distribution network can withstand loadings from extreme weather and climate change events. Pole load analysis plays a significant part in identifying system resiliency.

What is Storm Hardening?

Storm hardening is the process of replacing and retrofitting the existing poles in a grid infrastructure. Thus ensuring the utility poles are better-suited to endure loadings from extreme weather conditions. In short, storm hardening is one of the processes grid infrastructure undergoes to attain system resiliency.

Hardening initiatives have become standard practices for utilities serving areas prone to extreme weather events and other environmental factors. The storm-hardening process mainly focuses on sustaining the utility poles against hurricanes, tornadoes, and ice storms.

In 2017 alone, two hurricanes cost a Florida utility 2.5 billion dollars. As the frequency of these weather events increases, so too does the price tag.

Mitigating these hazards has quickly become a critical piece of system resiliency supported by regulations.

Regulations help build resiliency by setting a common standard by which a pole owner can judge resiliency and compliance across their entire network.

How do we create a resilient grid?

Due in part to the risk of pole failure caused by storms and other natural events, utilities are designing their electric grid above and beyond the minimum standards required in the National Electric Safety Code (NESC). The NESC offers a set of minimum guidelines for designing and constructing electric infrastructure that increases safety and creates system resilience.

The strength and loading section of the NESC presents several major design factors to consider when performing a loading analysis on a distribution network.

NESC Grade of Construction

Under the NESC, utility poles can fall under three different grades of construction. The grade generally determines the margin of safety. Generally, higher grades of construction mean a higher degree of system resiliency.

GRADE B

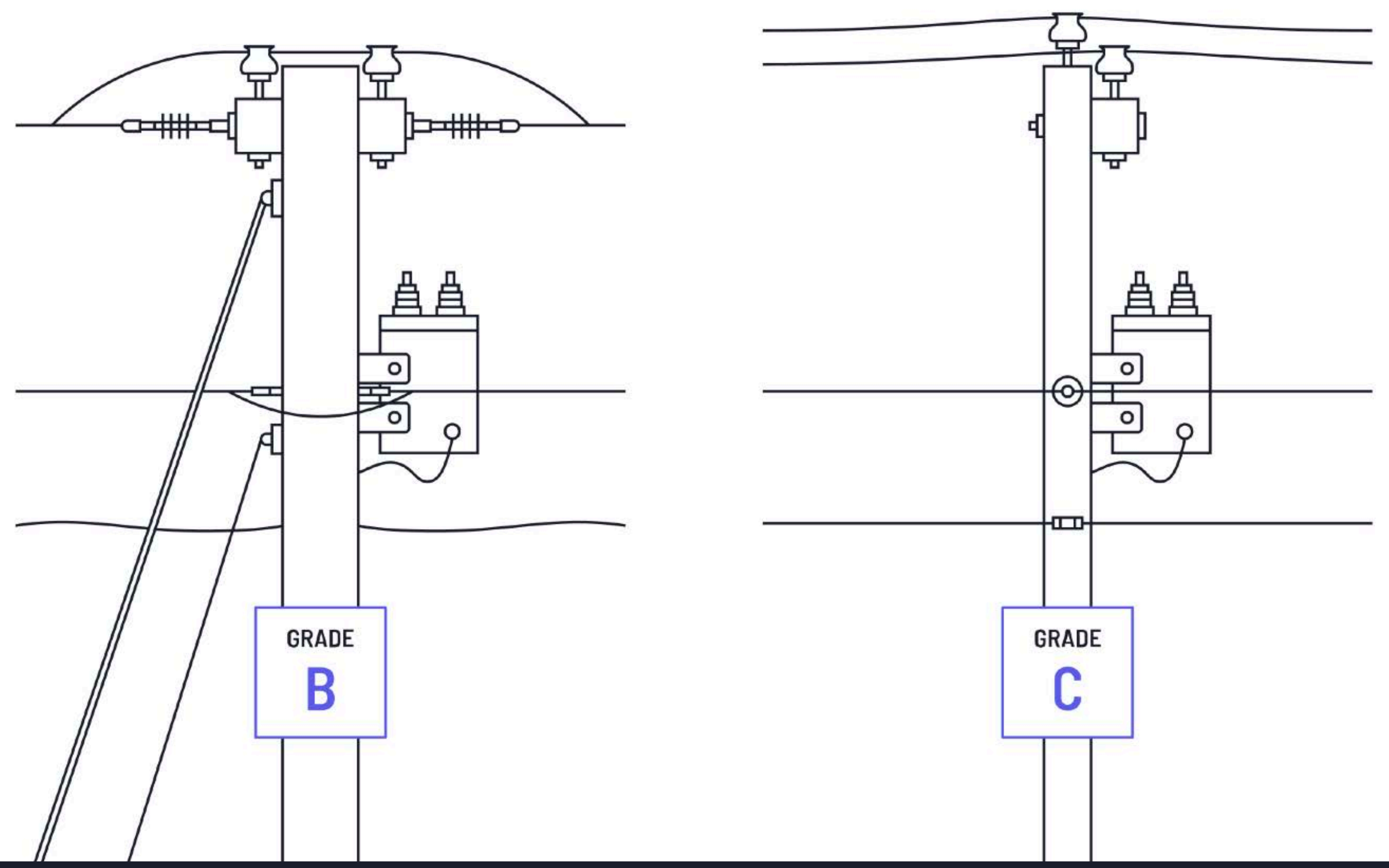
- High margin of safety
- Required when the pole supports spans that cross limited access highways, railroads, and navigable waterways.

GRADE C

- Most common and provides a basic margin of safety
- Utilized for the typical power and joint-use distribution pole
- Two separate grades for crossing and elsewhere

GRADE N

- The lowest grade of construction
- Mostly used for emergency and temporary construction
- Not allowed for poles supporting electric facilities.



For each NESC construction grade, load and material strength factors are applied during the analysis process.

According to electricalengineeringresources.com:

"The Load Factor (LF) accounts for the uncertainty of the given load and/or simplifying assumptions made in the analysis. This factor increases the applied load on the structure based on the required construction grade.

The strength factor (SF) decreases the effective strength of the structure. The Strength Factor accounts for the variability of the resistance property."

NESC Weather Loadings (Rule 250)

Given the exposure of poles to weather events, NESC provides three weather loading requirements. Of the three, the load that has the most significant effect on the pole rules the design. The rules are:

General Ice and Wind (NESC Rule 250B)

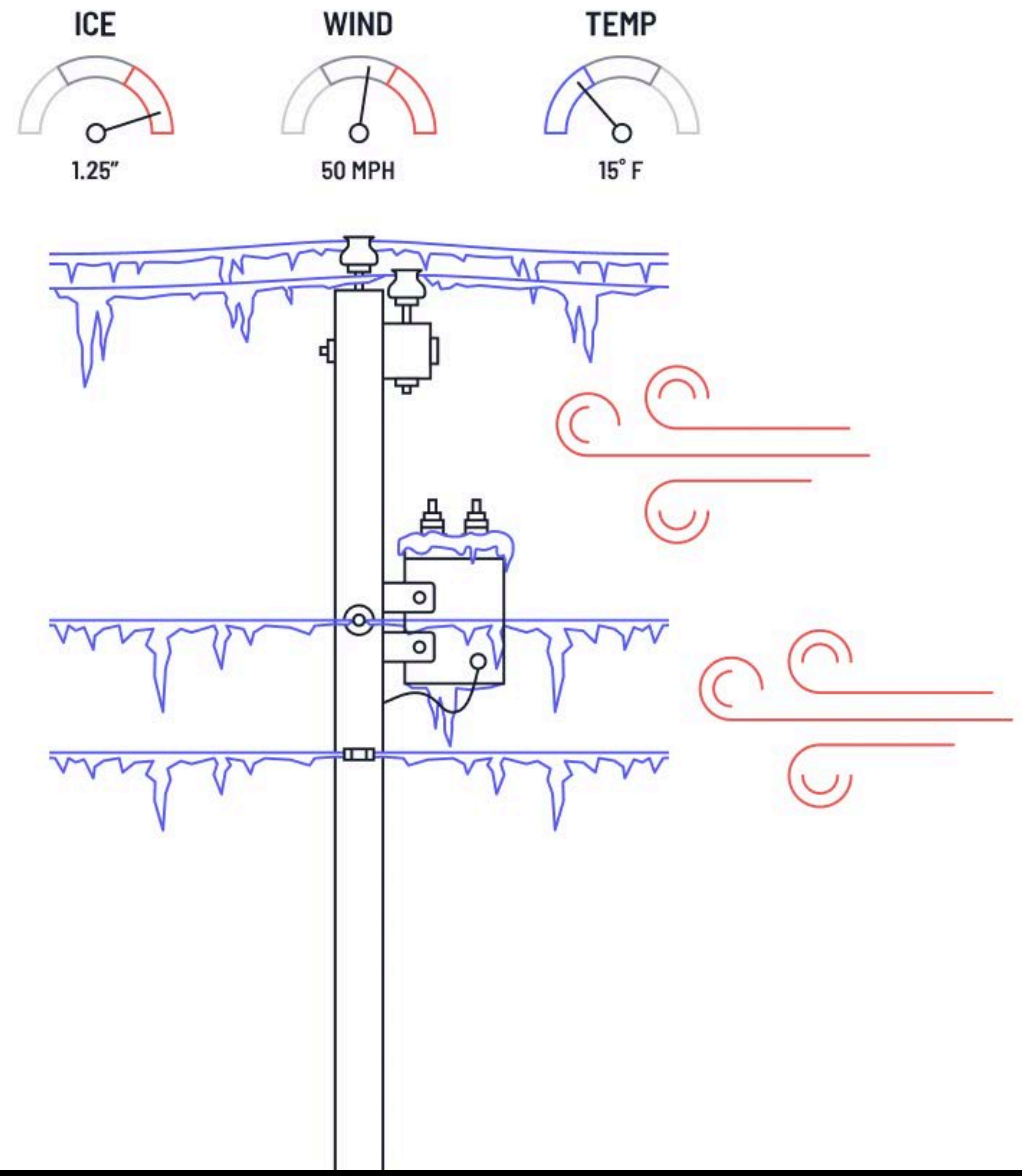
- Heavy, medium, or light load analysis is needed based on the location

Extreme Wind (NESC Rule 250C)

- Required for poles 60+ feet above ground to withstand winds up to 150 mph
- Commonly used on poles less than 60ft for hardening feeders to improve system resiliency, restoration times, and reliability indices

Extreme Ice with Concurrent Wind (NESC Rule 250D)

- Provides geographic ice and wind loadings based on historical meteorological data
- Ice loads can reach 1.25 Inches with wind speeds up to 60 mph



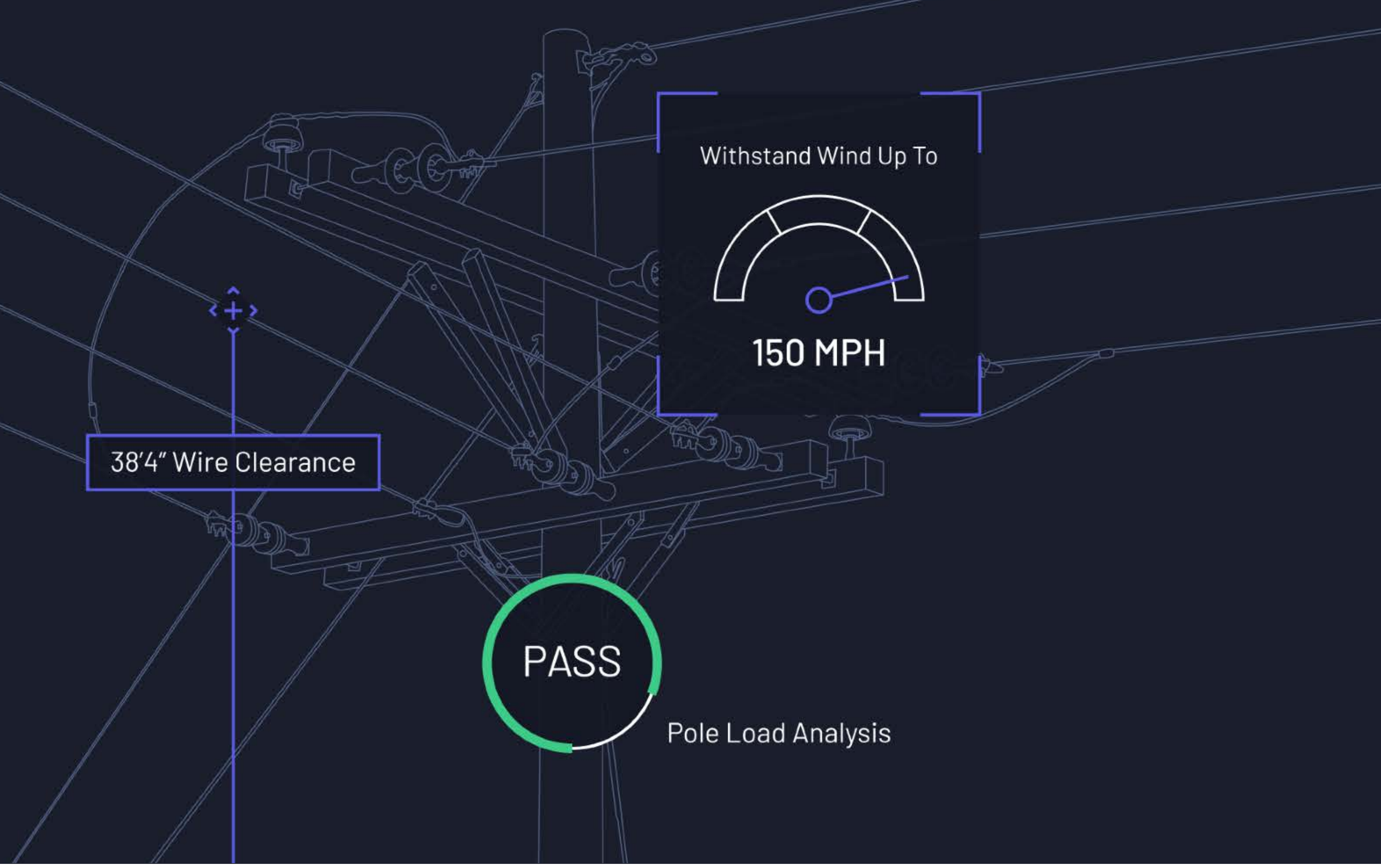
Performing pole loading analysis using NESC load cases will help gain an understanding about the percent loading on the pole. Poles with utilization percentages at or above 100% do not meet NESC minimum requirements. Therefore, these poles should be replaced, re-enforced, or re-engineered.

For example, if a pole is loaded to 110% capacity, owners will know that in case of extreme climatic conditions, the pole will not necessarily withstand that weather event and could be a point of failure on the grid.

So, what do all these requirements mean for a more resilient network? They set the bar for mitigation against all of these environmental factors and provide the baseline for safety and resilience. The question then becomes, where do you start?

Accurate Pole Load Analysis creates a more resilient system.

A more resilient network starts with data.



Information about the pole's condition allows the power companies to take proactive measures to minimize the consequences of extreme climatic events. A study by the National Institute of Building Science determined that every $1 spent on hazard mitigation saves society an average of $4. By extension, the money spent by pole owners on resilience pays off handsomely as the frequency of major climate events increases.

How could pole owners apply their spending to resilience and compliance? Simply put, an accurate Pole Loading Analysis can determine a network's resiliency.

To complete pole loading analysis, pole owners need to go to the pole in the field to collect data physically. The data includes information about pole properties, type and size of equipment, line angle for the wires, attachment heights, and pole condition. A fielder can collect this information in various ways, but not all of them are created equal in terms of collection speed and accuracy.

Once the information is obtained from the field, a back-office engineer can perform pole loading analysis to evaluate the pole's loading to capacity ratio.

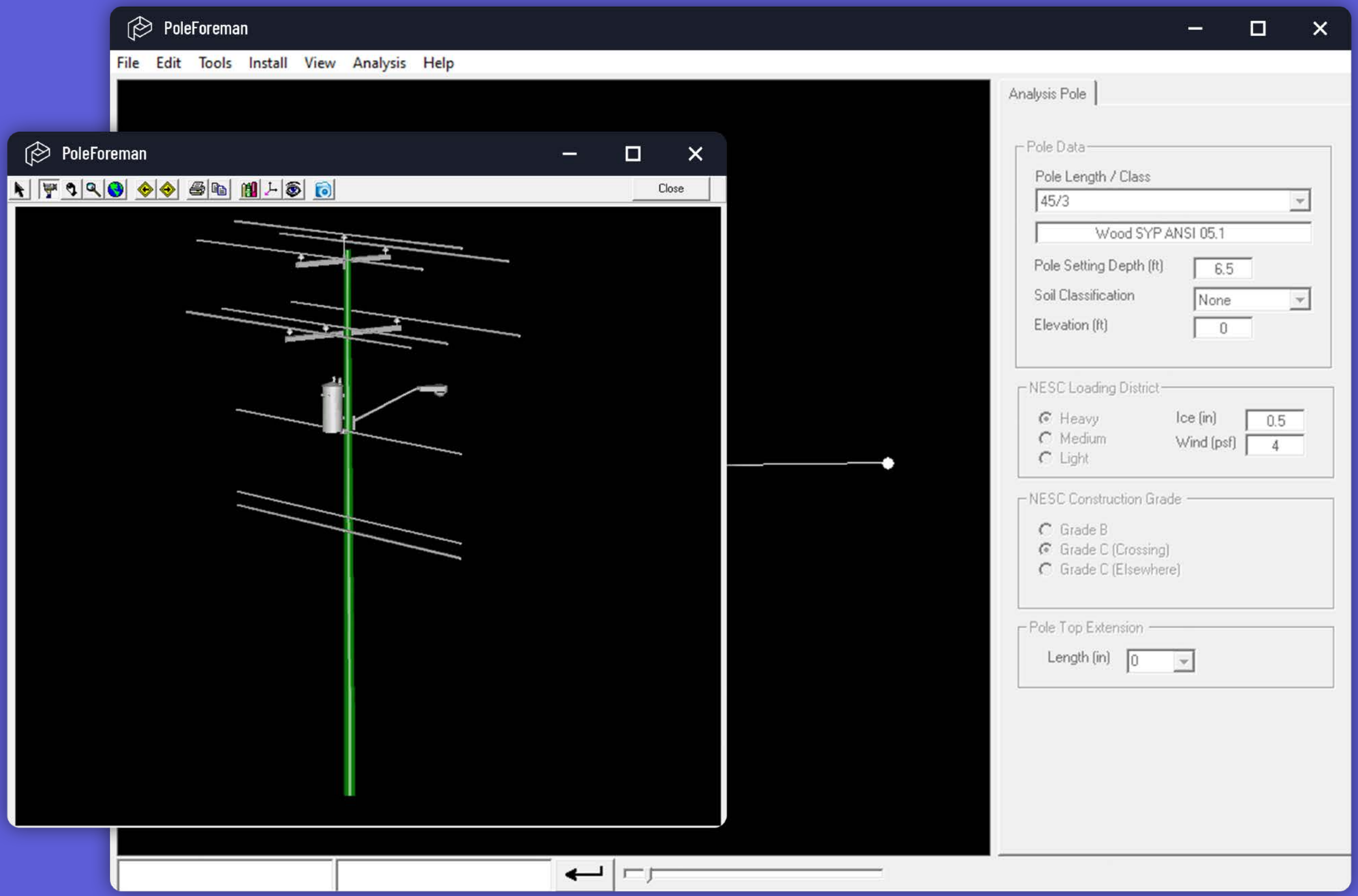
A traditional loading capacity is the ratio of the applied load to the pole strength for a given load case (specific wind, ice, and temperature). This ratio gives an idea of any excess strength capacity of the poles and determines if the poles comply with the NESC requirement. In addition, it also allows a utility company to evaluate if a storm hardening initiative will be required.

In addition to understanding the need for storm hardening, pole load analysis makes pole owners aware of the weaker points in the grid.

Knowledge of these weak points allows owners to identify the possible failure points that would be realized in an outage event and allocate resources to mitigate the hazard.

Leverage pole load analysis software

Anyone who has completed pole loading analysis by hand can tell you that it is by no means a fast process. Pole loading analysis software reduces the human effort involved in designing the power grid. Software, such as PoleForeman, SPIDAcalc, O-Calc Pro, or QuickPole allows users to quickly build a model of poles as they exist in the field. The model is then used to ensure the NESC standards are met. In addition, users can quickly alter attachment height, line angles, etc., and get the analysis report for a high number of poles in a short period.



Accurate. Reliable.
Defendable pole load analysis.

IKE's PoleForeman analysis software has been the industry standard for nearly two decades.

Today, PoleForeman continues to deliver utilities accurate, reliable, and defendable pole load analysis.

PoleForeman allows organizations to accurately build the structural model, measure clearances using native build tools, and perform detailed analysis.

With Ike's PoleForeman in your toolkit, your organization will have the definitive leader in pole load analysis software to perform loading calculations, determine pole strength utilization, and comply with National Electrical Safety Code (NESC) safety requirements.

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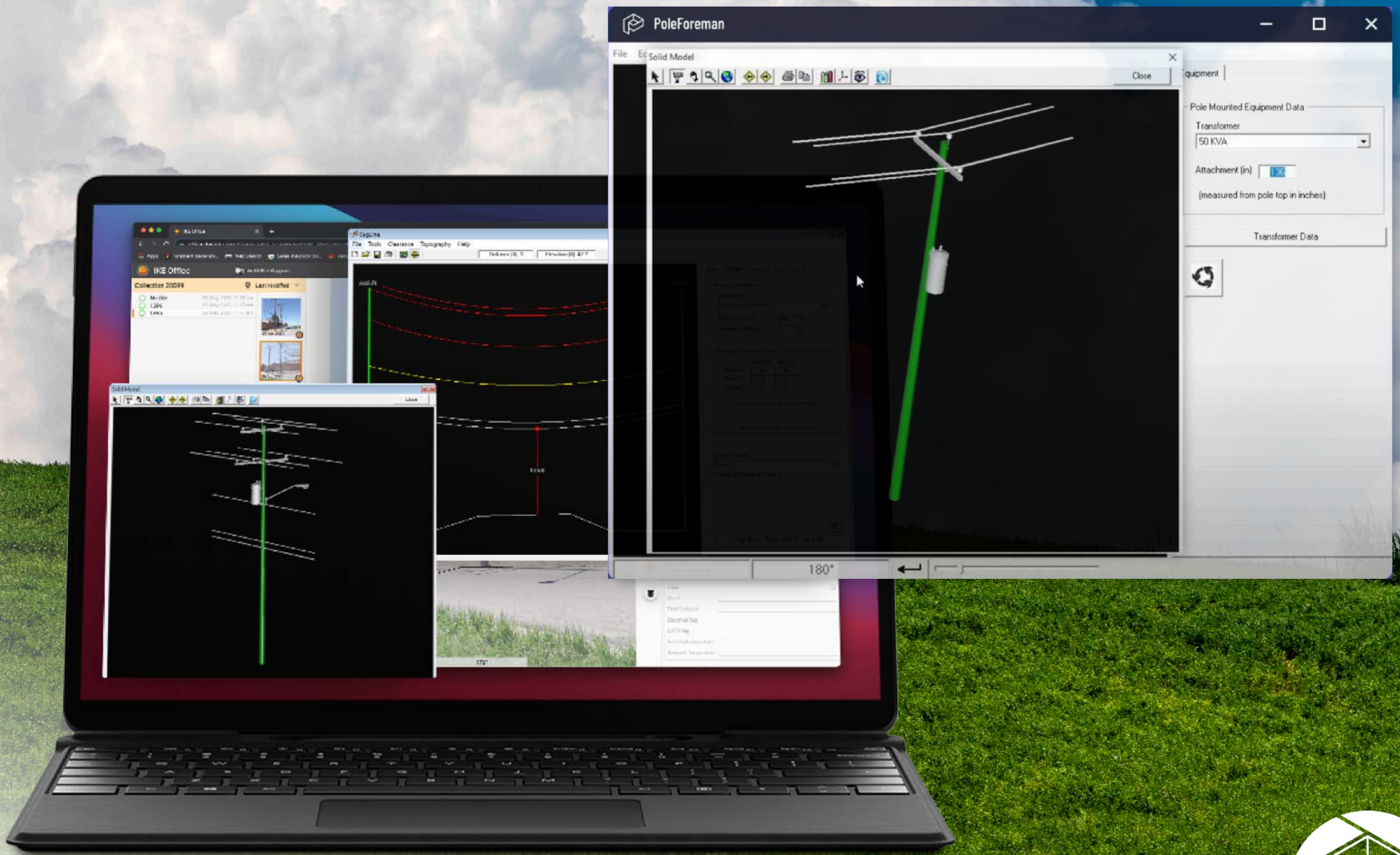


The Importance of Data for an Electric Utility

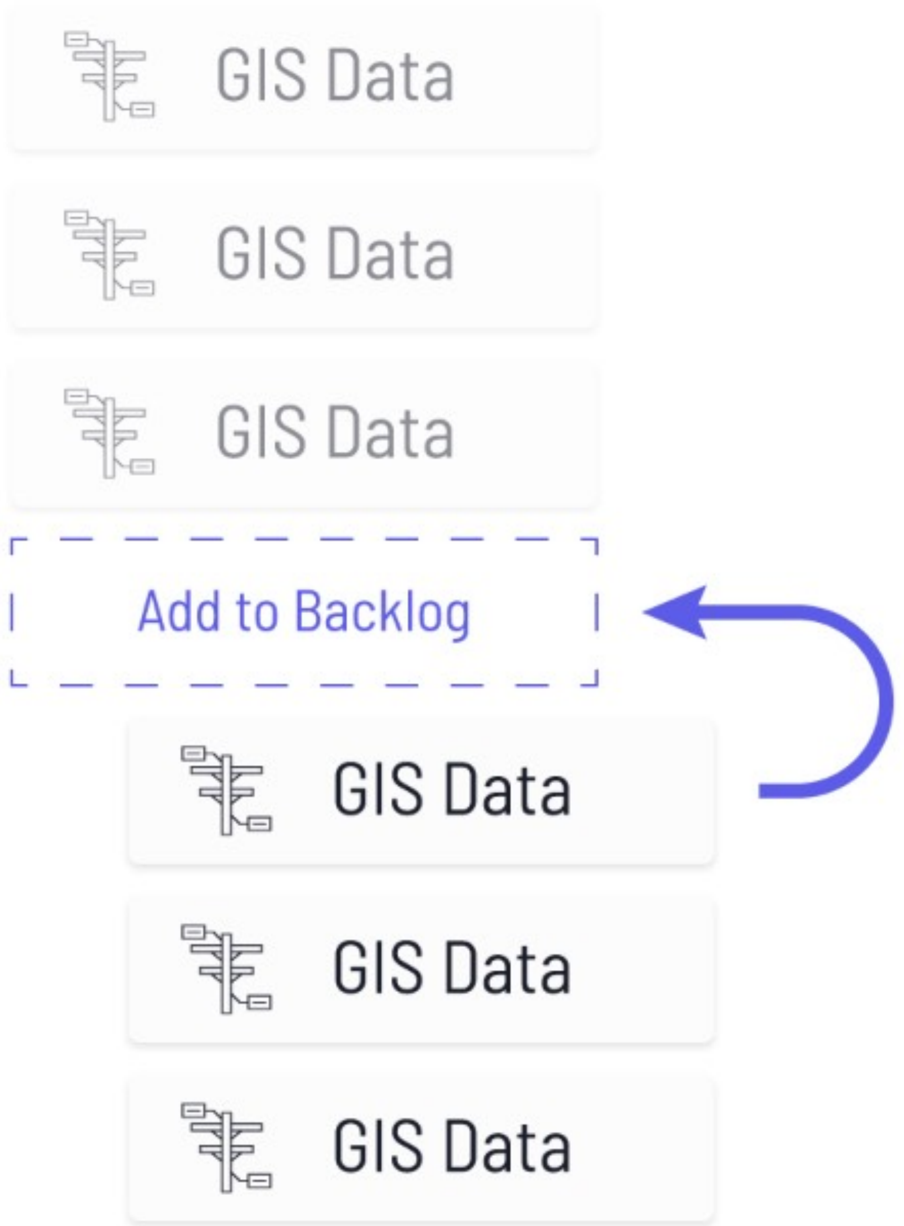
In many cases, a typical electric utility geographic information system (GIS) contains only a fraction of what is required for managing a smart grid. Typically, that data is too unreliable to use in smart grid applications. For example, electric utility GISs may not include which customers are connected to which transformer. If the utility includes this information in the GIS (and many do not), it is often incomplete or incorrect. Many electric utility GISs cannot identify the phase(s) each customer is using, and they may not include network topology or what is connected to what.

Other missing data may include streetlights, distributed energy generation such as rooftop solar photovoltaic (PV) panels, poles' type and condition, joint use, and encroachment.

Correcting this data is often a hit-and-miss affair depending on which department within the utility undertakes the data correction project. It is not uncommon for various departments within a given utility to conduct pole inspections and inventories for only their department's specific needs, neglecting the data needs of the rest of the company.
Compounding the problem is the vast array of tools used by the various consumers of pole surveys or inventory projects.

Planners tend to use GIS tools. Engineers and designers utilize computer-aided design (CAD) tools. Construction folks in the field use paper CAD drawings. Asset managers use FM, GIS, or integrated tools.

Fashioning architecture engineering and construction (AEC) and geospatial data into an efficient data flow from planning through design and construction through operations and maintenance represents a challenge that remains a problem for utilities. For many utilities, the backlog of as-builts and updates waiting to be entered into the GIS stretches into months. The result is that GIS data is often permanently out of date, inhibiting management and field staff from relying on this data operationally.



"For many utilities, the **backlog of as-builts and updates waiting to be entered into the GIS stretches into months**, with the result that **GIS data is permanently out of date**, inhibiting management and field staff from relying on this data operationally."

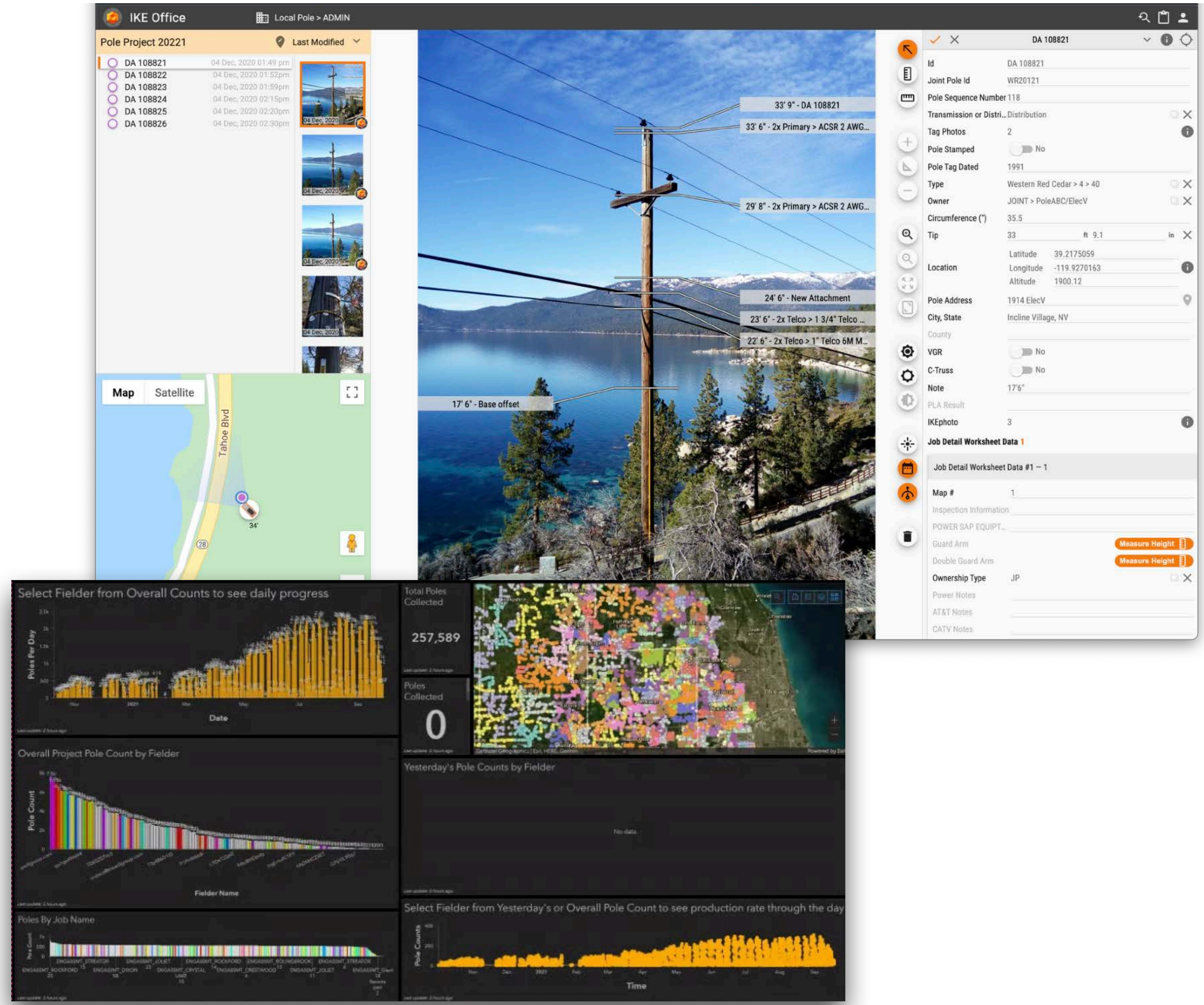
There are signs that modern technology is beginning to offer a solution to the problem of developing and maintaining an accurate digital model of electric power grids. Data collection of field assets and subsequent analysis are more sophisticated. Field surveys are still the norm, but devices to capture and analyze the data continually improve.

Manual, in-field data collection allows for the input of the field personnel to describe intangible situations that may impact properties such as pole loading.

Handheld devices remain one of the most accurate and inexpensive methods to obtain data for pole load analysis (PLA). Pole load analysis identifies the forces acting on a pole (from the cables, hardware, and more) and analyzes its structural integrity. Pole loading analysis starts with surveying an existing pole or using build specifications for new lines. Pole heights, pole type, pole class, pole location, and surveying existing structures on either side of the pole are recorded for analysis. Noting any third-party cables and identifying their types and locations is essential for the pole load analysis as other utilities may use utility pole assets in a manner unacceptable to the pole owner and the applicable regulations. If the load being calculated exceeds what it can handle, the pole structure needs to be enhanced or replaced.

Data from the pole loading analysis survey needs to be convertible into the form used by the analytical software. For example, PoleForeman, O-Calc Pro, Quick Pole, and SPIDAcalc formats need to be supported. As mentioned above, pole survey data needs to be usable by other utility data users. Hence, file formats ranging from KML (keyhole markup language) to CSV (comma-separated value) need also to be supported.

Utilities must analyze pole inspection technologies in light of not only the immediate pole analysis requirements but the data needs of the utility as a whole. Data used by other departments, the ease of data storage, and dissemination are equally crucial to the utility.



Utility Poles in the World of 5G

5G, like other types of cellular networks, transmits wireless signals through a network split into different "cells".

5G is a formidable power when it comes to new network technologies, but what does it have to do with utility poles? Simply put, the rollout of 5G relies on small-cell technology attachments being placed on existing utility poles. It sounds simple enough, but telecommunications are subject to certain regulations, such as those from the National Electrical Safety Code (NESC), the Original General Order 95 (GO-95) and the Federal Aviation Administration (FAA).

With so many players involved, 5G attachments require collaboration from several different entities, including service carriers, utility providers, and regulating bodies. Fortunately, the promises of new technology tend to bring out the collaborative nature in different industries. That holds true for 5G.

5G, like other types of cellular networks, transmits wireless signals through a network split into different "cells." These cells allow your device to switch between towers when necessary and get the best performance. 5G increases wireless capacity and offers other benefits like low latency and speed improvements. While 4G networks use large cellular towers to create cells, 5G uses a type of technology called "small-cell" base stations. These base stations are discreet and installed on existing pieces of infrastructure, primarily utility poles, allowing more dense coverage.

5G has been rapidly gaining momentum since research began in the early 2010s. But what is it about 5G that's prompted the world to spend $2.64 billion on 5G infrastructure in 2020 alone? The effects of 5G go far beyond how quickly you can conduct an internet search on your cellphone. It has wide-reaching capabilities in many different sectors, like health care and transportation, thanks to 5G's ability to offer speed, reliability and greater device connection density. The market is expected to grow significantly, with a compound annual growth rate (CAGR) of 77.6% between 2020 and 2027.

Everything from remote surgery to vehicle-to-vehicle communication to Internet of Things (IoT) devices can benefit from the reliability and low latency of 5G.

Working With Utility Poles and 5G Nodes

Installing 5G nodes calls for collaboration between various parties. The process must be approved by safety, electricity and utility authorities regarding topics like accessibility, backhaul solutions, minimum clearances and attachment guidelines, which can vary widely and necessitate collaboration between parties. The installation must be cleared with the city and cannot interrupt other utilities, such as water lines.

Locations for 5G small cells must have fiber-optic cables in place and, if creating a new utility pole, a foundation and electrical connection. The pole, whether existing or new, needs to be structurally sound to support the addition of the new equipment.

The installation must be cleared with the city and cannot interrupt other utilities, such as water lines.

Most installers look for certain characteristics in aerial infrastructure before placing 5G nodes, such as:

- **A weight minimum:** Poles that are class 2 or heavier are generally sturdier and may offer longer lifespans, supporting the 5G node on infrastructure that will last.
- **Specific pole top extension heights:** Pole top extensions determine the tallest height of the pole and how far above the ground the node can be placed.
- **Ground-based inspection locations:** Ground-based inspections are easier to conduct and cost less for the telecommunications company.

Since small cells are discreet and the boxes don't take up much space, they're relatively easy to work around and shouldn't cause any problems for other types of utility work. Adding small cells to aerial infrastructure will be a major part of the 5G rollout and call for an increase in skilled installations. Easy measurements and on-the-go assessments can help installers accomplish the job faster and more reliably.

Joint Use Agreements and the 5G Rollout

With such discreet and plentiful placement options, 5G attachments sound easy to implement. In reality, 5G utility pole attachments involve requirements from the pole owner, the Federal Communications Commission (FCC), and a complex payment model in which service providers and tower owners share access to the utility pole.

Joint use agreements are a critical part of this equation, as they outline who owns and pays for the space and resources for maintaining utility poles.

Utility and telecommunications providers have been working together to add telecommunication tools and community antenna television (CATV) on power poles for some time.

5G adoption, however, has created uncertainty about who actually attaches the 5G equipment. In the past, these areas of ownership were separate, with additional connections like fiber and internet being placed in a dedicated communications space. 5G attaches to the primary area, traditionally owned by the utility. This overlap forces more collaboration between the two parties.

5G adoption has created uncertainty about who actually attaches the 5G equipment.

These agreements dictate who shares access to utility structures. In this case, we're often working with phone and power lines. These agreements should help to speed up the process and simplify the demands of 5G rollout. In reality, there's some red tape in place that can slow the process down. The sheer quantity of applications is enough to put a strain on approvals, with over 417,000 cell sites added just in 2020. This is especially relevant in dense, urban areas, where the number of nodes will be higher than in rural areas.

Another challenge comes from the time limits put in place by the FCC, which give utility providers certain timeframes, called shot clocks, to make decisions to support faster rollouts.

Utility providers have 90 days from receipt to review an application for:

- Co-locating a facility other than a Small Wireless Facility using an existing structure
- Deploying a Small Wireless Facility to a new structure.

Those applications include make-ready designs, permits and construction. The timeframe for these approvals used to be longer, and if the permit ruling timed out, telecom companies could move forward with work.

While the shorter timeline can add an extra challenge, it helps utilities better manage their needs and speed up revenue flow.

Reality Capture and How it Impacts the Utility Industry

Reality capture is a set of technologies that allow a user to replicate the physical world and turn it into a virtual reality or digital realm.

It's transforming industries, especially when used to capture an as-built structure's location, features, and character as is often the case when electric utilities use the technology to maintain and improve their grid infrastructures.

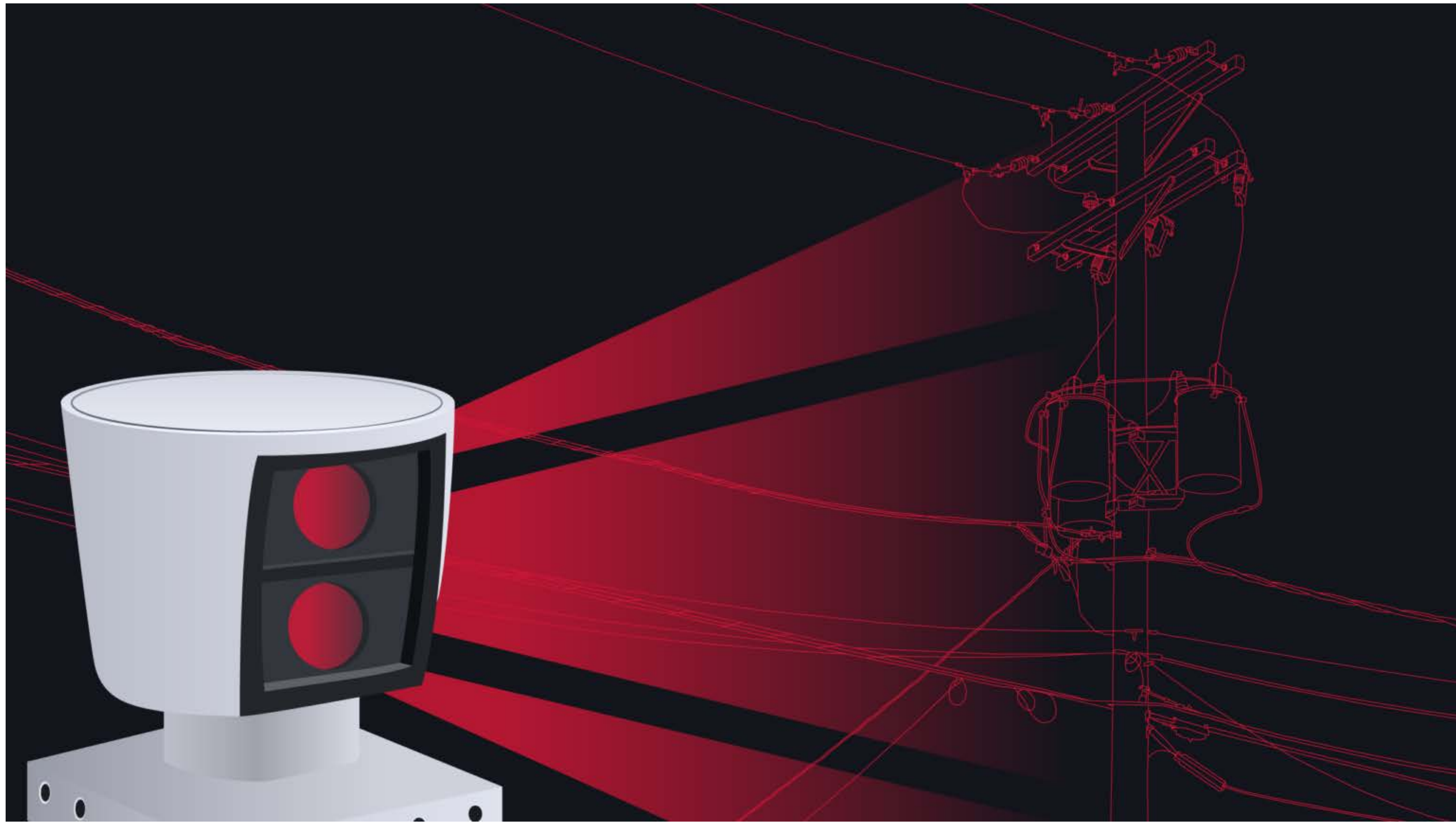
There are some cutting-edge technologies required to get you there — point clouds, photogrammetry, and LiDAR, to name but a few. Each technology is fundamentally different but conceptually the same and with its own strengths and weaknesses.

What is LiDAR?

LiDAR (Light Detection and Ranging) is a popular reality capture technology today. LiDAR uses ultraviolet, visible, or near-infrared light to map spatial relationships and shapes by measuring the time it takes for signals to bounce off objects and return to the scanner. LiDAR can capture accurate measurements for entire buildings down to the smallest architectural detail. Each scan comprises millions of individual measurements, one pulse laser at a time. Once these scans are processed, LiDAR data becomes point cloud data.

LiDAR is independent of lighting conditions. Because it brings its own light source, it can be done in cloudy conditions or at night. The use of lasers in the non-visible spectrum is especially appealing to law enforcement and the military.

Because of the flexibility of the wavelength of light, LiDAR can map virtually any condition. Metal, as well as for non-metallic materials, can be scanned successfully along with ground and water features. Capture modes include hand-held devices for close-up or interior mappings such as machinery or artwork. Terrestrial capture usually takes the form of one or several tripod-mounted laser scanners strategically located around larger internal or external areas. Terrestrial capture includes mounting the LiDAR on vehicles such as service trucks to capture linear assets in view of the road. Aerial capture is used for capturing large areas, long features, or remote assets. Though the distance from the ground leads to a lower resolution, the small width of the laser beam can map objects to a resolution of 12in (30cm) which is often sufficient for analysis.



What are point clouds?

Point clouds are the output of LiDAR scans and consist of a large number of points that have location information with them. This is obtained from knowing the precise location of the laser and the relationship to the object. Through a process called registration, these points are converted into surfaces to develop a recognizable model of reality. The dramatic miniaturization of powerful computers and the latest developments in machine learning and cloud computing have improved the speed and robustness of the models.

The models created by LiDAR and point clouds can lead to precise location and shape information. What is lacking and becomes a time-consuming process for these technologies is matching color up with the shapes detected by the laser. This is where a technique called photogrammetry comes into play.

Photogrammetry uses photographs and, therefore, ambient lighting conditions to gather data. Large numbers of photos are taken at different angles to obtain the geometry. Overlapping from one photo to the next helps to “knit” the images together.

The photos can come from various sources, from high-precision optics to commercial cameras. Pictures taken from the web or unsuspecting tourists can even be used. Images can even be extracted from video data.

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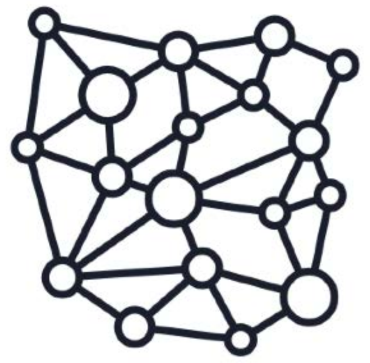

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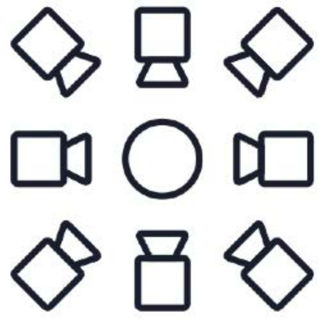
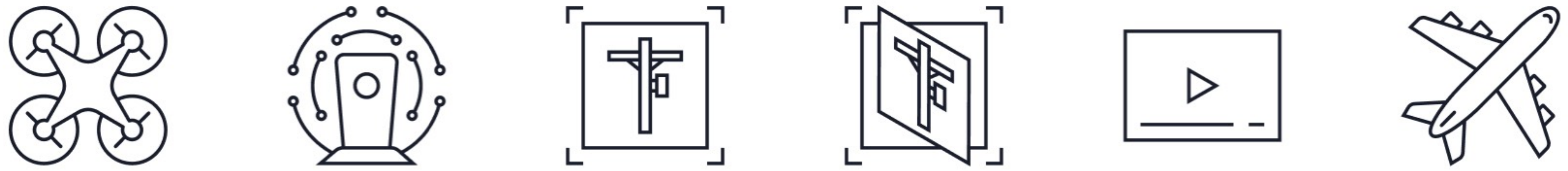


A robust analytical solution for developing a virtual model from these techniques and extracting usable information must support any type of image, including those acquired from drone, thermal, LiDAR, 2D, 3D, video, and aerial sources.



Drones **LiDAR** **2D** **3D** **Video** **Aerial**

The created model can then be integrated into what is known as a digital twin. A digital twin is the melding of precise shape and dimensional information of an object or connected group of objects with near real-time data collected from an array of sensors throughout the physical world. Digital twins are a way to reimagine monitoring and controlling systems in the real world and are gaining traction with all different types of utilities.

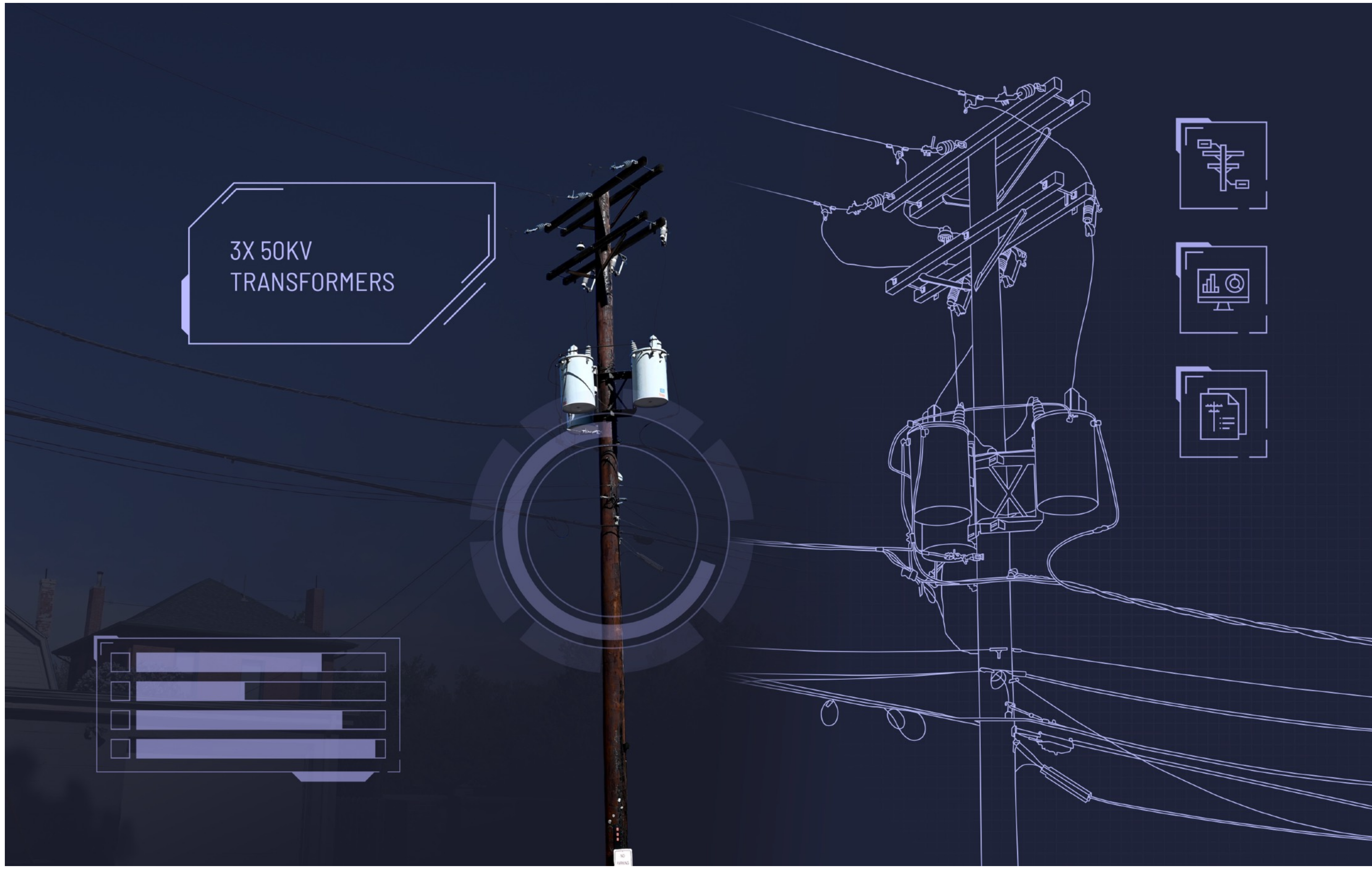
Digital Twins and the Utility Smart Grid

At its core, a digital twin is a virtual representation of a physical asset combined with an operational status used to understand or predict the physical counterpart.Digital twins are created by leveraging the system data that defines the original asset and its physical world situation captured through sensors.

Creating and maintaining a digital twin of an electric grid is essential for developing and maintaining a smart grid.

One cornerstone of the smart grid and, therefore, digital twins is the accuracy of the geospatial information system (GIS). Utilities have been wrestling with the challenge of creating accurate digital twins for decades.

In many cases, utilities' GIS data is still not much closer to what is required for such a task. As a model that virtually represents their physical counterparts, the digital twin information needs to be complete, accurate, and connected.



Traditionally, utilities of various types have utilized a manual pole survey to inspect and inventory their outdoor assets. Very sophisticated devices have been developed to make this process as painless as possible, and these devices still have a place in utility inventory management.

Computerized analytical techniques that utilize powerful algorithms and machine learning are emerging, driven by the need to deliver precise data quicker and at a lower price.

Two very different technologies that deliver precision in different areas have surfaced. The first technology combines precise location information and the very detailed information provided by laser reflection technology. This technique is known as LiDAR (Light Detection and Ranging) and has become very popular for data-starved utilizes. It complements and sometimes competes with the second technology, Photogrammetry, which uses images derived from photos or videos under ambient lighting.

Where LiDAR can provide very precise shapes and structures, Photogrammetry adds something LiDAR can't, color.

Just like their real-world counterparts, a set of component digital twin devices can be assembled into an equipment digital twin. A set of equipment digital twins can be made into a local network digital twin. A set of local network digital twins can be assembled into a grid digital twin, and so on.

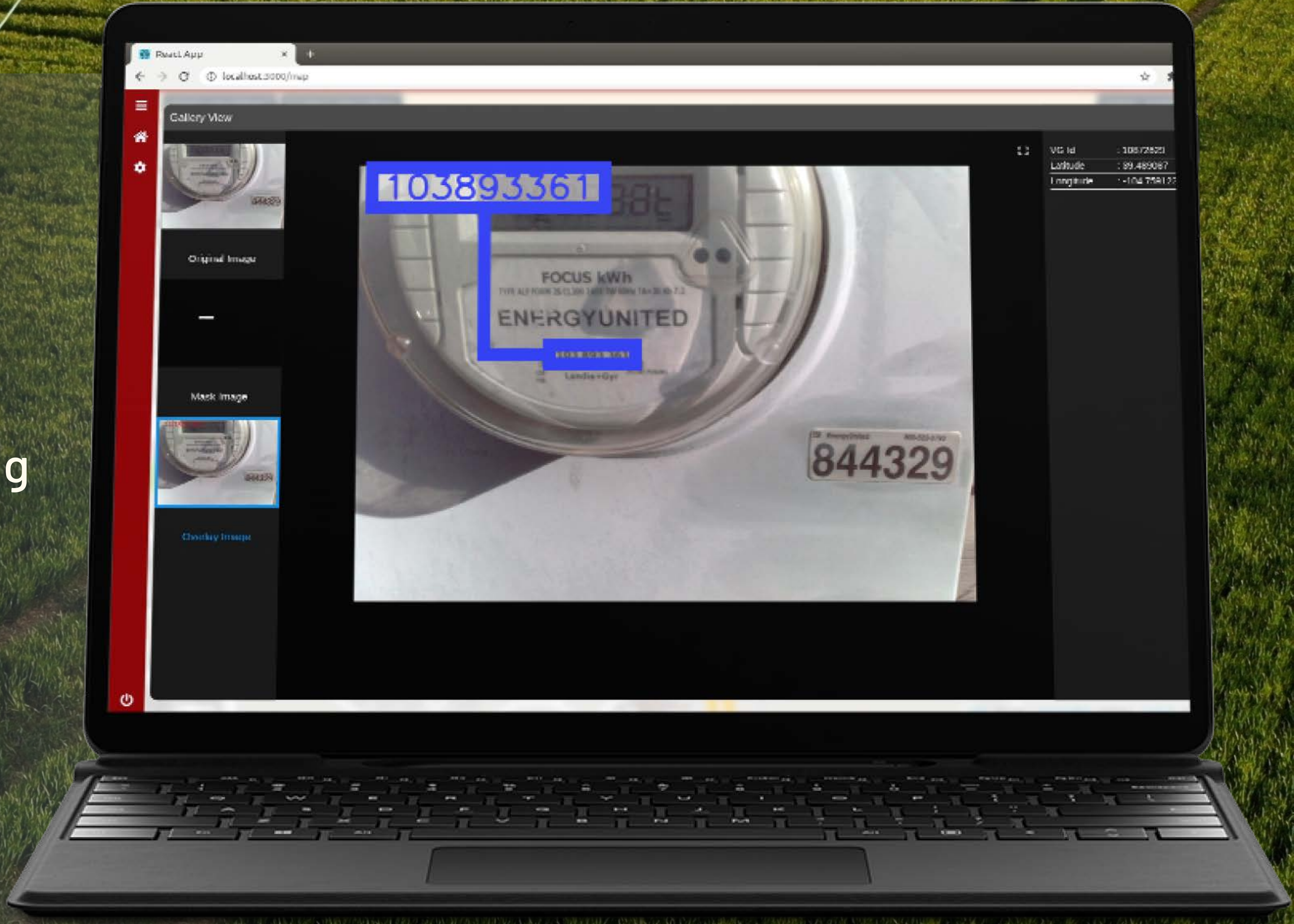
Given the history of utility challenges in developing and maintaining accurate GIS data, these new approaches represent a beacon of hope which may enable utilities to cost-effectively develop a digital twin of their networks that is an essential prerequisite for creating a smart grid.

Save Time. Save Resources.
Gain the Insights.

IKE Insight is a utility's go-to tool for gaining actionable insights from any new or existing digital imagery or data sources whether they are from drone, lidar, aerial, satellite or thermal.

IKE Insight automates manual or otherwise time-intensive processes, allowing you to inspect more without suffering budget increases.

By empowering you with artificial intelligence and machine learning, IKE Insight allows you to greatly scale your knowledge of grid infrastructure quickly and efficiently.



ike GPS

How can utilities use technology to address our skilled workforce shortage?

A growing industry concern

In every corner of the electric utility industry, we struggle to hire, train, and retain a knowledgeable and experienced workforce. The National Association of State Energy Officials (NAESO), representing 56 energy offices of States, Territories, and the District of Columbia, recently published a report stating that just over **84 percent of energy employers are experiencing difficulty hiring qualified workers.**

84% **of Energy Employers**
are experiencing difficulty hiring qualified workers
According to the National Association of State Energy Officials (NAESO)

Combined with the fact that 40% of the electric utility workforce will be eligible for retirement by 2030, we begin to see the magnitude of the crisis. The top reasons cited for hiring challenges have been lack of experience, inadequate training, and lack of technical skills. Complex work in the utility industry requires a level of expertise not often found in a new crop of candidates.

While efforts are underway by government agencies and utilities themselves to assist in closing the knowledge gap, the industry's workforce has been stretched thin.

One potential solution can be found in the adoption of new technologies to modernize our existing workforce. By embracing digital transformation, we can lower barriers to entry into the workforce and streamline workflows to further advance our energy infrastructure.

However, it is no simple task. We need strong utility leaders to champion the adoption of new technology and own the associated organizational change. Thankfully, we are seeing progress. Innovative utilities and engineering service providers (ESPs) are rapidly deploying commercially viable technologies in the field, where manual processes are still prevalent.

Drivers for workforce change

Innovation

Today, Utilities and ESPs are starting to embrace innovative commercialized technologies that provide high ROI business use cases, including Artificial Intelligence and Machine Learning. These use cases address constraints and eliminate human error in the field while delivering highly accurate results. The deployment of innovative technology with demonstrated high value will leave more time for our limited workforce to accomplish what is important.

Outsourcing

Historically, outsourcing has been cast in a negative light. Many see it as an unnecessary displacement of the workforce to another party just to drive down operational costs.

In years past, when outsourcing meant losing jobs to another person, that may have held true. But today, outsourcing human activities to technology can be revolutionary in terms of productivity for both utilities and their existing workforce.

Instead of looking at outsourcing in terms of operational cost, it should be viewed through a productivity lens and seen as a key optimization advantage. With strategic outsourcing using technology, experienced utility employees can better leverage their years of expertise and pass on knowledge more easily.

Modernization starts with digitization. Analog processes represent a massive barrier to creating a more modern workforce. Often, manual data entry points in the field are a major culprit in holding back modernization. Today utilities can leverage advancements in artificial Intelligence (AI) and machine learning (ML) to create digital entry points for data while improving efficiency and accuracy. Utilities can also synchronize disparate data and digital imagery available from existing transmission and distribution (T&D) utility repositories or outside organizations. Then, improved digital data leads to superior results over traditional field crew-based asset condition inspections.

Thanks to advancements in object recognition technologies and their algorithms, design engineers can easily link GIS data and improve workflows for projects such as:

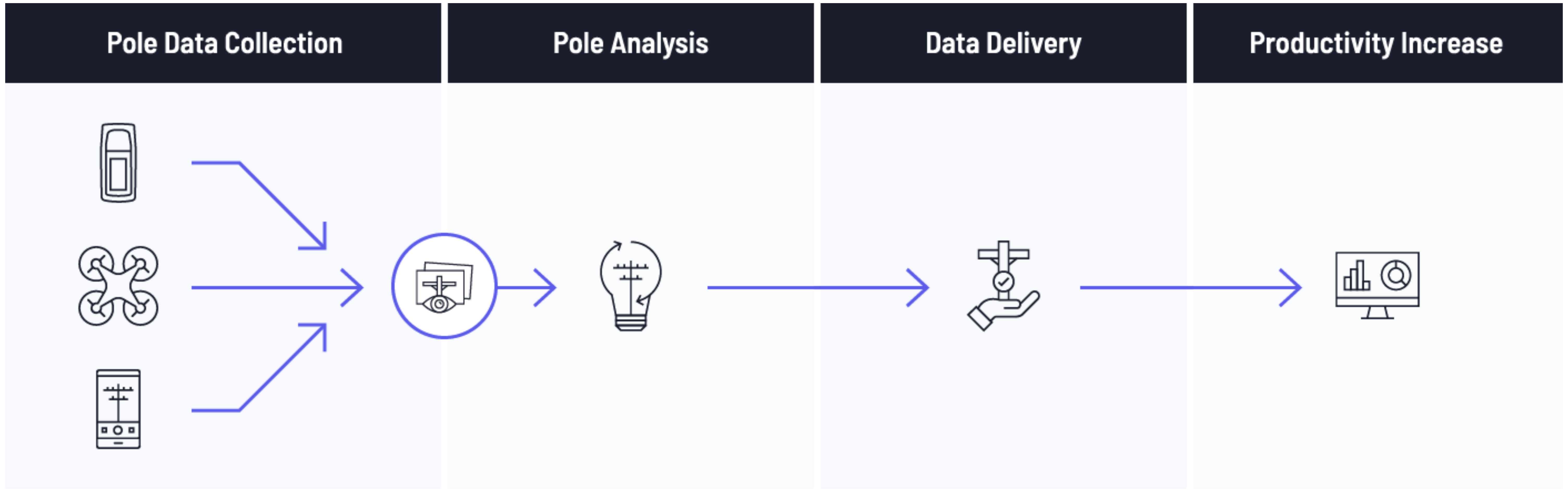
- Identification of defective equipment
- Improving data collection
- Identification of vegetation growth in the right-of-way
- High volume grid-wide as-built analysis

How do we modernize the workforce?
In two words... **digital transformation.**

Imagine having a technology partner provider who can ingest any existing digital imagery of distribution utility pole plant. It does not matter whether it was captured on previous audits or from one of many open public imagery sources. Then using AI and or ML, utilities could identify damaged pin insulators, missing guy markers, NESC violations, or damaged cross arms in a matter of days. In comparison with traditional methods, the use of technology removes months of waiting on a manual field inspection and provides results at a fraction of the cost.

Scenarios like the one above are not some far-off pipe dream. They are available today to any utility seeking to address the problems we all face in staffing. As the crisis of mass retirement looms, the solution can be found in technology. Simply put, **the industry needs to modernize the workforce through digital transformation and the removal of high volume, error-prone, manual field collection of critical data.**

To do so, we need to arm our workforce with technology solutions and process flow improvements that deliver accurate results at lower costs while improving safety metrics and shortening time to project completion. By starting there, we prepare an aging workforce to better leverage the expertise they have. Then, we open the door to a new generation who will lead the charge towards a more modern workforce.



Pole Data Collection	Pole Analysis	Data Delivery	Productivity Increase
Data comes in from any images source	Poles and equipment are analyzed using AI/ML	Pole deliverables are created and deliviered	Productivity increases without the need for additioal skilled workers

Where to start

1. Embrace new technologies by committing to an exploratory proof-of-concept engagement. Seek to fail fast, iterate, adjust and focus on automating your workflow wherever possible.

2. Engage in an initial discovery workshop with leading technology companies that have demonstrated commercial success in your desired use case.

3. Be open to sharing sample data that can be analyzed to properly identify project scope requirements.

4. If the proof-of-concept delivers the desired results, move quickly to further define what a full program should look like. Then, scale operational efficiencies and move to program execution.

5. For T&D energy delivery utilities looking for promising use cases focus on identifying and automating current manual activities and processes in the field. That's where the low-hanging fruit is located that provides high-impact ROI projects that benefit all stakeholders.

Because the grid is only as strong as its weakest pole.

For more than a decade and a half, ikeGPS and its suite of industry-leading grid infrastructure data acquisition and structural analysis tools have helped utilities efficiently acquire and dependably analyze the data needed to properly assess and maintain their grid infrastructures.

One of the best aspects of IKE's suite of tools is that its individual components–the IKE Device, IKE Office Pro, PoleForeman, and IKE Insight–can work together as a master suite of tools OR individually complement and enhance whatever existing tools your organization may already have.

With ikeGPS's suite or individual tools in your toolkit, your organization will quickly find and fix anything that stands in the way of your grid infrastructure so you can deliver a reliable future to the customers depending on it.

IKE Device

IKE PoleForeman

IKE Office Pro

IKE Insight

Go ahead. IKE is Listening.

Contact ikeGPS and lets us know how we can help you protect your grid infrastructure integrity.

ike GPS

Go ahead. IKE is Listening.

Contact us