STANTEC era

ENERGY & RESOURCES ADVISOR

THE AGING INFRASTRUCTURE ISSUE

OLD FOR THE NEW

The world's existing energy infrastructure is key to meeting renewable energy goals.

BY MARIO FINIS

→

Extreme drought at Lake Mead, Nevada

The cameras capture a row of local leaders posing with gleaming golden shovels in an open field. They are celebrating the start of construction on a new solar farm. Or a new wind farm. Or a new battery field.

This scene is taking place around the world as communities celebrate their progress in developing new renewable energy generation to help lower greenhouse gas (GHG) emissions.

But to reach that cleaner energy future, we need more than just new construction. Investment in our existing infrastructure is also needed to achieve our energy goals safely and reliably—and, it can get us there faster and cheaper. Our existing power plants, power lines, distribution systems, and other energy system components are getting older each day, and they weren't built to handle the new demands being placed on them.

We cannot build our way to a clean energy future overnight—we must rebuild existing infrastructure as well. Rebuilding and upgrading our energy infrastructure will get the most out of our existing assets and create a solid foundation for the future. The energy market's existing infrastructure is critical to meeting renewable energy goals. It needs to be redesigned, upgraded, and optimized in order to meet those clean energy goals and increase resiliency.

For decades the American Society of Civil Engineers[1] has issued reports on the state of our infrastructure in the United States. Year after year, the energy sector has received dismal grades. This is not a new issue, but it is an urgent issue as we fall further behind in the race to save our planet[2]. >

We cannot simply build our way to a clean energy future overnight—we must rebuild existing infrastructure.

OUR ELECTRIC SYSTEM IS NOT BEING USED AS ORIGINALLY INTENDED

Most of the world's existing infrastructure is being pushed to their design extremes.

The push to build wind farms and solar facilities is changing the characteristics of our power supply. Most electrical grids were designed around a centralized energy source like a coal, nuclear, or hydropower facility. Now, as we push to smaller distributed energy sources like wind and solar, our grids must be redesigned to maintain safe and reliable power delivery. Instead of a centralized plant distributing energy to the end-user, power is now being pushed back onto the grid. Power must now flow in two directions on a system that was designed for only one direction.

The largest global source of renewable energy is hydropower. A vast majority of these facilities were built in the 1950s and 60s.

↑ Excessive rainfall in California in 2017 resulted in the use of the emergency spillway at Oroville Dam for the first time in 50 years.

Now, these facilities are forced to run on one of two extremes. Extreme weather is causing reservoirs to fill to capacity, requiring emergency spillways to be used—sometimes with damaging results. And during times of extreme drought, reservoirs are low and plants are forced to run at lower levels, less efficiently than originally designed. Because there isn't enough energy storage, the intermittent nature of new renewables (generating only when the sun is shining or the wind is blowing) is causing existing plants to start and stop much more frequently. This causes additional wear and tear and also affects today's largest form of energy storage—pumped storage hydroelectric plants. >

"WE MUST REVIEW AND ADAPT OUR EXISTING ENERGY INFRASTRUCTURE IF WE HOPE TO ACHIEVE OUR GOALS OR CLEAN AND SUSTAINABLE ENERGY SOURCES."

MAKING OUR EXISTING ENERGY SOURCES CLEANER

If a community has a goal to be 100% renewable by 2050, how will they be powered for the next 20 or 30 years before they reach that goal? Natural gas is often cited as the 'bridge'[3] fuel to get us to our ambitious goals. A sound gas energy infrastructure is vital to our clean energy future. Making sure that existing energy infrastructure is in good condition helps us reach our goals safely and reliably.

Many energy providers are converting power plants from burning coal to using cleaner, cheaper natural gas. How do we transport gas to these power plants safely and efficiently? Pipelines.

Pipelines have tremendous benefits beyond carrying fuels to power plants. For one, pipeline infrastructure lessens the amount of fuel being transported by road or rail, reducing vehicle exhaust emissions and improving traffic safety. And if we invest in our existing pipelines, we can reduce methane leaks—which could have some of the biggest benefits on reducing GHG globally.

We must acknowledge the energy transition taking place. Our existing energy sources are critical to bridging the gap to a 100% clean energy future. >

REDUCING INEFFICIENCIES AND INCREASING PERFORMANCE

We need to use our infrastructure at its optimal capacity if we hope to achieve a clean energy future. With upgrades to existing systems, we can take proven energy forms and make them more efficient. We need to keep our baseload energy stable to maintain reliability while adding new sources like wind and solar power.

According the DNV-GL, an international accredited register, “efficiency gains play a far greater role in helping to cut emissions over the coming two decades than the combined contribution of the switch to wind, solar, and electric vehicles.”

We are not only seeing this in the power industry, but on mine sites as well. This is key because the materials needed to fuel our green revolution all must be mined. The precious metals in solar panels to lithium in storage batteries and electric vehicles are found in the ground, so mine sites must continue to operate efficiently in order to extract them. The trouble is, many of these sites have been in operation for more than 50 years. So, it is essential that we upgrade equipment and technology to make these sites more sustainable and energy efficient.

Additionally, upgrading existing hydropower facilities with the newest, most efficient turbines could increase production by 30% or more. And, investing in our power system, with upgrades such as high voltage direct current (HVDC) technology, could make distribution easier, safer, and more efficient. >

“EFFICIENCY GAINS PLAY A FAR GREATER ROLE IN HELPING TO CUT EMISSIONS OVER THE COMING TWO DECADES THAN THE COMBINED CONTRIBUTION OF THE SWITCH TO WIND, SOLAR AND ELECTRIC VEHICLES.”

- DNV-GL (an international accredited register)

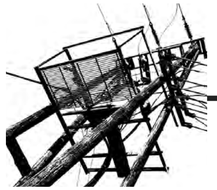
LIFESPAN OF OUR ENERGY INFRASTRUCTURE

Hydropower

100+

Hydropower facilities are designed with a 100 year lifespan. However, technology upgrades are needed throughout this time.

Power Delivery



25+

70% of the grid's transmission lines and power transformers are more than 25 years old. Most were not designed to meet the current energy demands.

100+

Mining

Mining sites can be operational for more than 100 years. Throughout their lifespan, equipment must be upgraded and assessed.

50+

Pipelines

Many of North America's pipelines are more than 50 years old. Ensuring these pipelines are structurally sound is essential to reducing leaks.

20+

Wind

Many renewable sources like wind and solar are new to the market. The design life of a modern wind turbine is 20 years.

REBUILDING A CLEANER ENERGY FUTURE

The resources dedicated to reducing emissions and building a clean energy future must include an investment in our existing infrastructure. While new construction may get the headlines and the limelight, rebuilding and reconfiguring our existing infrastructure is necessary, and, in most cases, faster and cheaper.

Enhancing our existing infrastructure is the best chance we have in combating climate change before it's too late. ■

Mario Finis

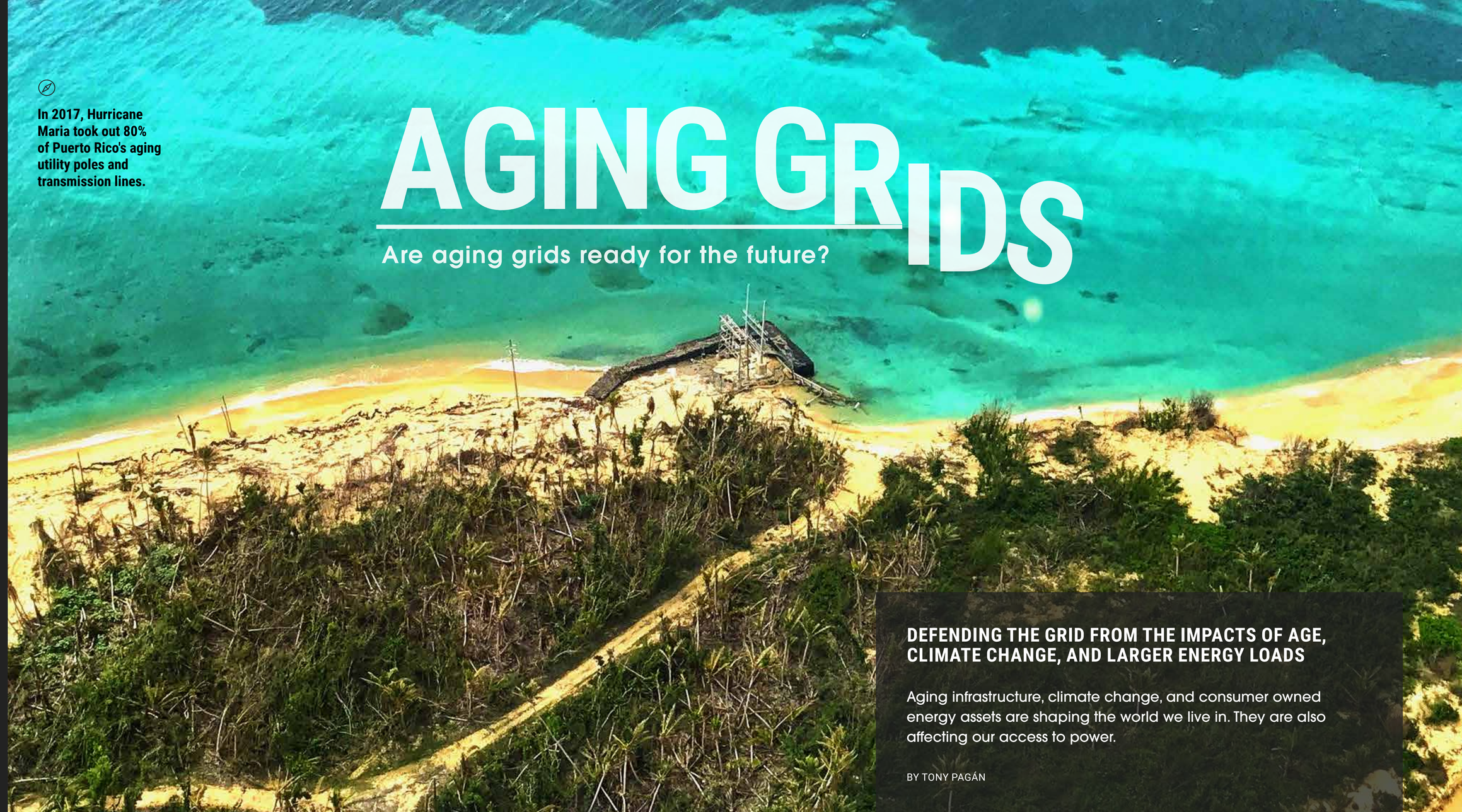
Executive Vice President, Energy & Resources

Mario is the executive vice president for Stantec's Energy & Resources business, serving clients around the world.

MORE FOR YOU →

Are aging grids ready for the future?

LEARN MORE
ABOUT THE ENERGY TRANSITION



In 2017, Hurricane Maria took out 80% of Puerto Rico's aging utility poles and transmission lines.

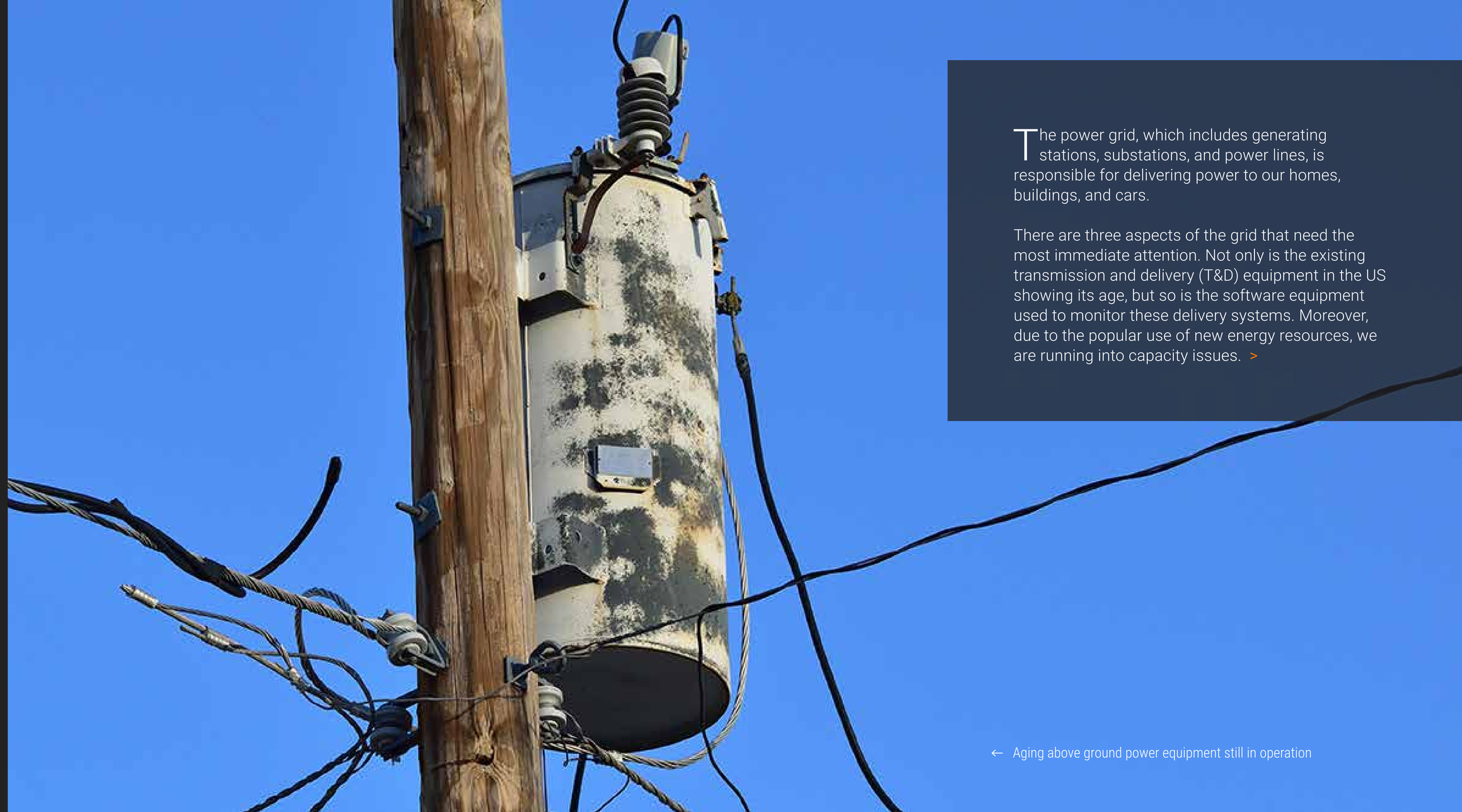
AGING GRIDS

Are aging grids ready for the future?

DEFENDING THE GRID FROM THE IMPACTS OF AGE, CLIMATE CHANGE, AND LARGER ENERGY LOADS

Aging infrastructure, climate change, and consumer owned energy assets are shaping the world we live in. They are also affecting our access to power.

BY TONY PAGÁN



The power grid, which includes generating stations, substations, and power lines, is responsible for delivering power to our homes, buildings, and cars.

There are three aspects of the grid that need the most immediate attention. Not only is the existing transmission and delivery (T&D) equipment in the US showing its age, but so is the software equipment used to monitor these delivery systems. Moreover, due to the popular use of new energy resources, we are running into capacity issues. >

← Aging above ground power equipment still in operation

The 2018 wildfire season in California was the most destructive and deadliest on record, burning almost 2 million acres.

Power infrastructure needs an upgrade

Physical assets, including T&D structures, have a limited life expectancy. Many of the older poles, towers, conductors, and transformers have remained in service past their useful life and were not built with higher temperatures and more intense storms in mind.

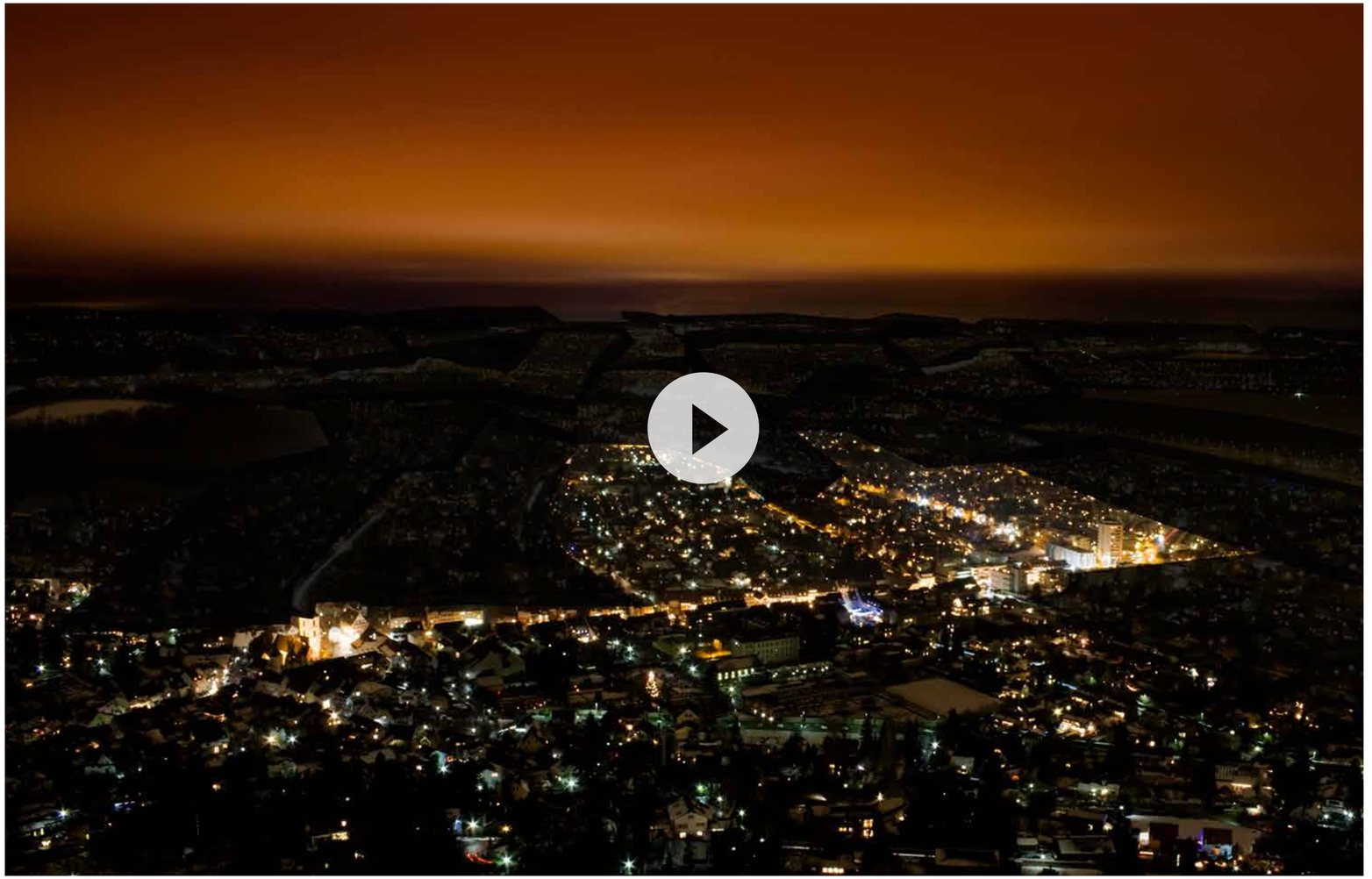
Utilities are now playing catch up, making significant investments to upgrade and replace deteriorated assets with ones that are designed to withstand the wildfires ripping through the west and the hurricanes tearing through much of the southern coastal states and islands.

Often triggered by aging T&D equipment, the number of wildfires is increasing at an alarming rate. In fact, the 2018 wildfire season in California was the most destructive and deadliest on record, burning almost 2 million acres.

Replacing above ground power lines and poles with underground facilities would seem like an obvious solution to these intensifying events. However, utilities are hesitant to adopt this solution, as underground lines remain vulnerable to extreme weather and are incredibly expensive. According to the Edison Electric Institute, burying above ground electric distribution systems can cost up to $5 million a mile in urban areas.

Thus, utilities are turning to an alternative and more affordable option known as fire-hardening—replacing wooden poles and towers with materials such as steel and concrete.

But fires aren't the only issue. In the last decade, hurricanes have posed a major threat to T&D structures. For example, in 2004, Florida suffered a series of storms that wiped out power across much of the state. In response, parts of the state began upgrading their infrastructure by hardening their equipment. After installing poles that could withstand 145 mph winds, loss of power has significantly decreased in the state. >



Updating how we monitor our energy

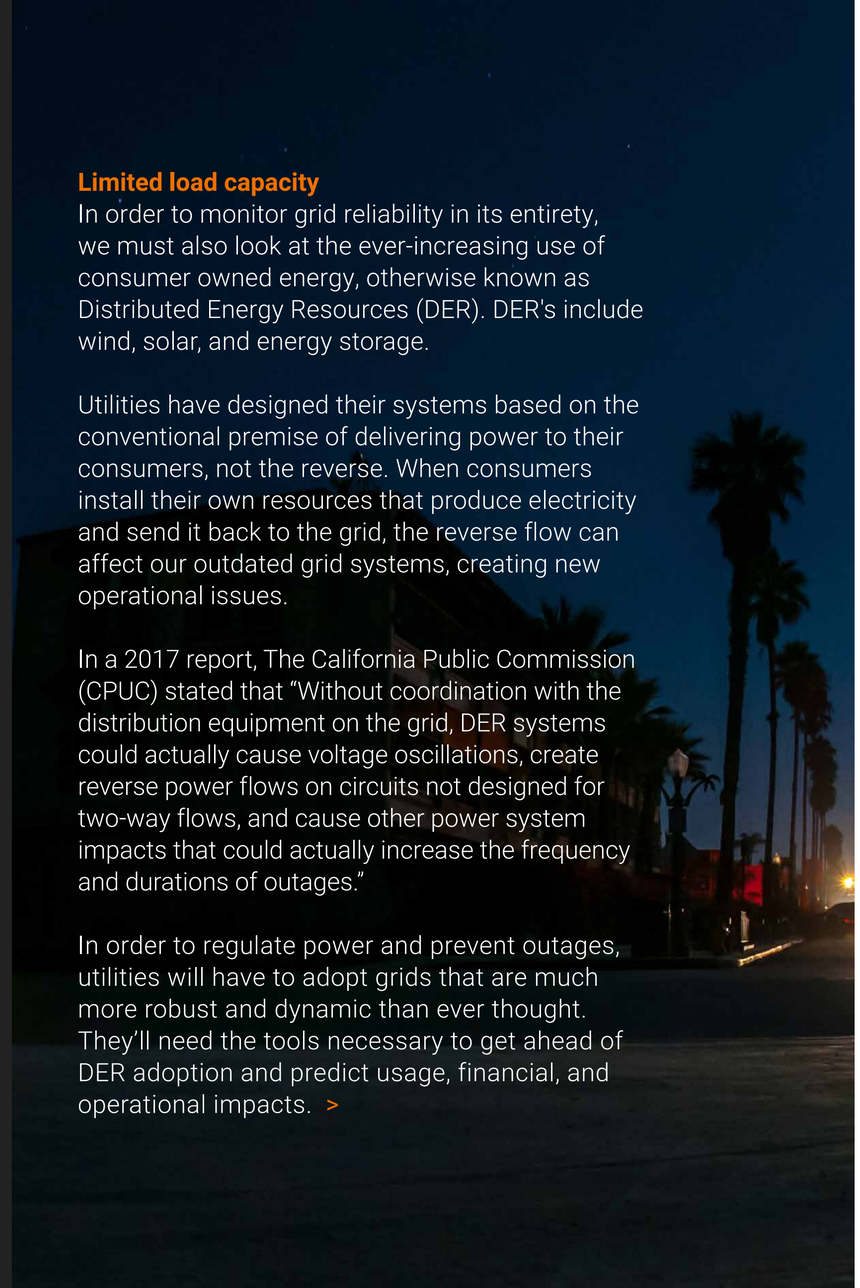
Perhaps less obvious but just as critical to the safe and reliable operation of the grid is the software that power utilities use to remotely monitor control stations around the country, known as supervisory control and data acquisition (SCADA) systems.

Much of these SCADA systems were built in the 1970's and 1980's when cyber security was not considered a threat. They were built to boost efficiency and safety—but not to fend off cyberattacks.

IF SUCCESSFUL, A CYBER ATTACK CAN POTENTIALLY DISRUPT AND SHUT DOWN POWER TO AN ENTIRE NATION FOR DAYS.

The Wall Street Journal reported in March 2014 that if only nine of the country's approximately 55,000 electrical substations went down—whether from mechanical issues or malicious attack—the nation would experience a coast-to-coast blackout.

In order to decrease future vulnerabilities, investor-owned utility companies will have to prioritize the security of these SCADA systems. >



Limited load capacity

In order to monitor grid reliability in its entirety, we must also look at the ever-increasing use of consumer owned energy, otherwise known as Distributed Energy Resources (DER). DER's include wind, solar, and energy storage.

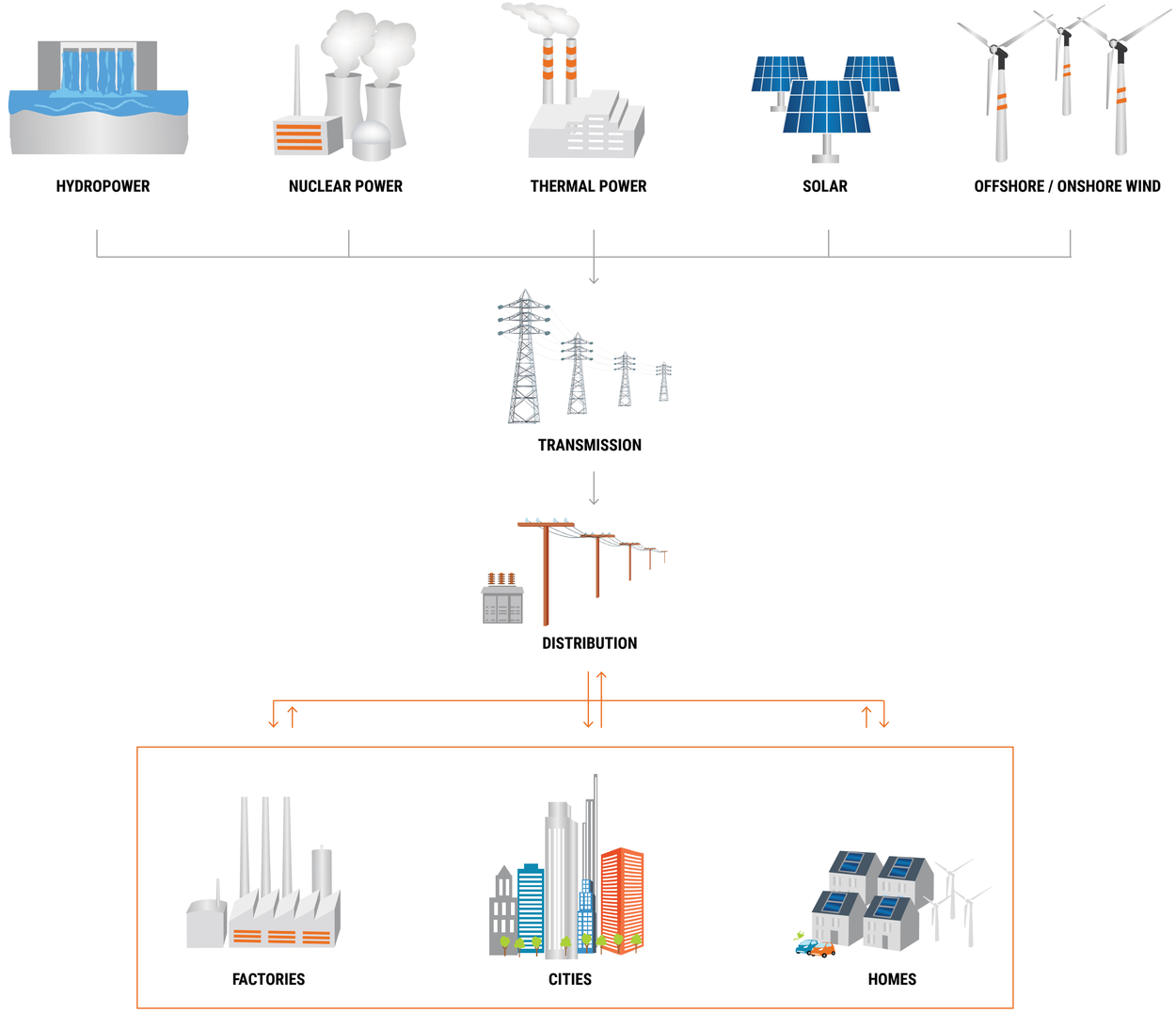
Utilities have designed their systems based on the conventional premise of delivering power to their consumers, not the reverse. When consumers install their own resources that produce electricity and send it back to the grid, the reverse flow can affect our outdated grid systems, creating new operational issues.

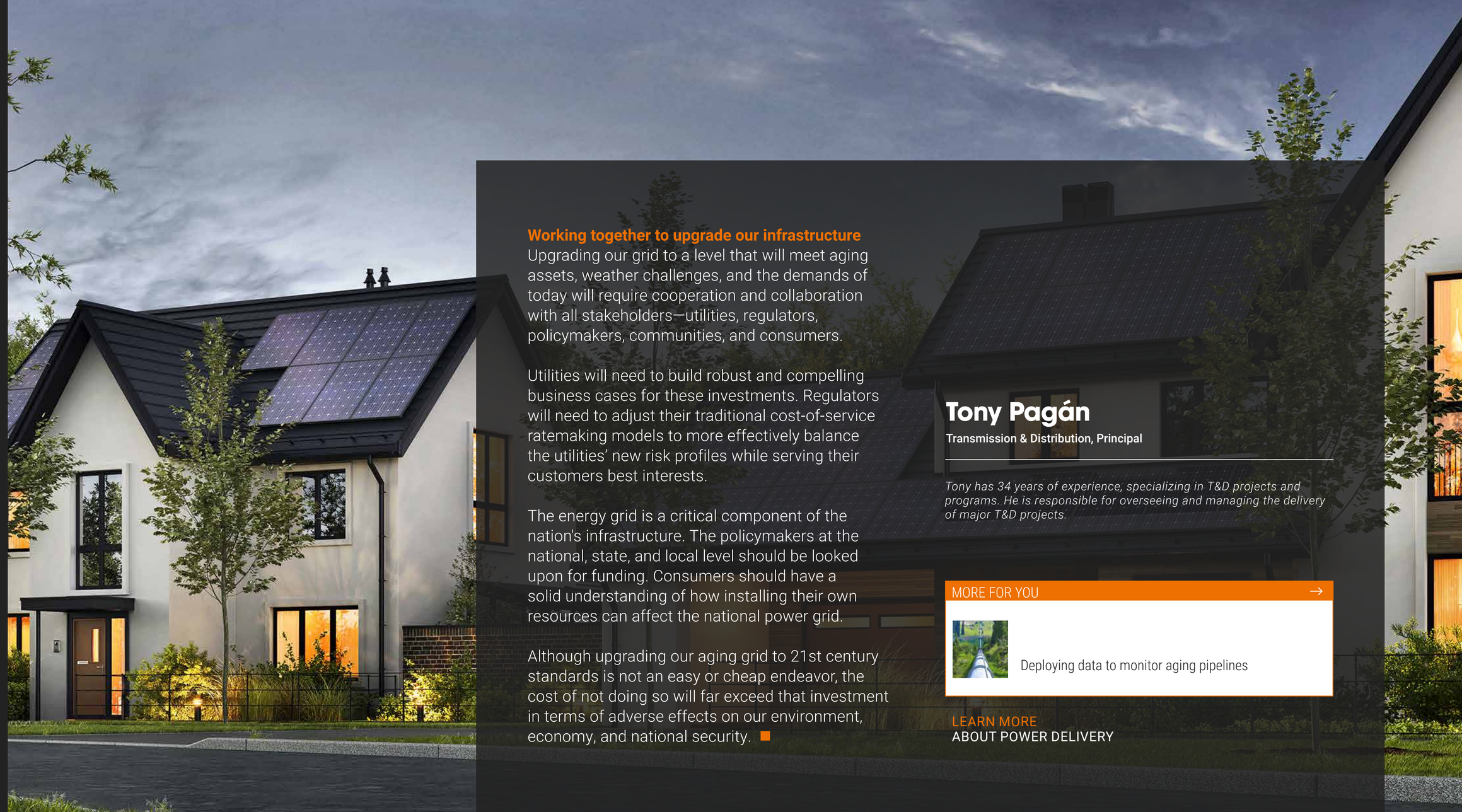
In a 2017 report, The California Public Commission (CPUC) stated that "Without coordination with the distribution equipment on the grid, DER systems could actually cause voltage oscillations, create reverse power flows on circuits not designed for two-way flows, and cause other power system impacts that could actually increase the frequency and durations of outages."

In order to regulate power and prevent outages, utilities will have to adopt grids that are much more robust and dynamic than ever thought. They'll need the tools necessary to get ahead of DER adoption and predict usage, financial, and operational impacts. >

FUTURE OF POWER GENERATION

Traditional power flowed one way from centralized power sources like nuclear, hydropower, thermal and wind. Now factories, cities, and homes are producing electricity for their own use and pushing power back onto the energy grid. This is creating operational issues.





Working together to upgrade our infrastructure

Upgrading our grid to a level that will meet aging assets, weather challenges, and the demands of today will require cooperation and collaboration with all stakeholders—utilities, regulators, policymakers, communities, and consumers.

Utilities will need to build robust and compelling business cases for these investments. Regulators will need to adjust their traditional cost-of-service ratemaking models to more effectively balance the utilities' new risk profiles while serving their customers best interests.

The energy grid is a critical component of the nation's infrastructure. The policymakers at the national, state, and local level should be looked upon for funding. Consumers should have a solid understanding of how installing their own resources can affect the national power grid.

Although upgrading our aging grid to 21st century standards is not an easy or cheap endeavor, the cost of not doing so will far exceed that investment in terms of adverse effects on our environment, economy, and national security. ■

Tony Pagán

Transmission & Distribution, Principal

Tony has 34 years of experience, specializing in T&D projects and programs. He is responsible for overseeing and managing the delivery of major T&D projects.

MORE FOR YOU →

Deploying data to monitor aging pipelines

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ABOUT POWER DELIVERY

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DEPLOYING DATA TO MONITOR

AGING PIPELINES

Data management is at the core of effectively monitoring aging pipeline infrastructure for Energy & Resources projects

BY MARK STRICKLAND AND DENNIS ZADERY

Pipelines are predominantly how the Oil & Gas industry moves its product.

In North America, millions of miles of pipeline infrastructure is used every day to safely and efficiently move energy and raw materials from production areas or ports of entry throughout the continent to consumers, airports, military bases, communities, and other industry partners.

While pipelines remain the safest way to move our energy products, there are still risks associated with the transport process—primarily oil and gas leaks. When a leak occurs, it can have severe negative environmental, social, and economic impacts for pipeline operators and their surrounding communities. To avoid these impacts, it is essential that we safeguard pipelines from the risks associated with a leak.

In order to maintain the highest standard of safety and security for pipeline infrastructure, we need to ensure that we are monitoring each line effectively. But at almost 3 million miles of gathering, transmission, and distribution pipelines in North America, how can we successfully manage them all?

By deploying a pipeline integrity data management solution.

HOW IS DATA MANAGEMENT CORE TO SUCCESS?

Data is increasingly seen as an asset. It can be used to promote better business decisions, optimize operations and maintenance, and reduce overall costs. We believe in managing our clients' key pipeline database management projects—starting in the design and planning phase to operational implementation and monitoring. The goal of these databases? To improve all aspects of pipeline safety—from environmental impacts and leak prevention, to resource prioritization and loss prevention.

What we've found is that strategic data management is key to effectively monitoring aging pipeline infrastructure. But, the successful implementation of a data management solution requires a deep understanding of the data and its functionality.

By combining expertise from a variety of data-driven fields, Stantec offers a complete solution by objectively analyzing the data management structure. We use multiple specialized lenses, including pipeline integrity, engineering, geomatics, and information technology services. This advances our goal of spatial data management, to organize spatial data from several sources and provide a full picture across functional work groups.

Our experience has demonstrated that by aligning three key principals when managing pipeline integrity data, we can significantly enhance the quality of information and function:

01 Data Integration

02 Geolocation

03 Analytics >

01 DATA INTEGRATION: A CENTRALIZED SOURCE OF TRUTH

When it comes to designing and operating smart pipeline infrastructure, all effective decisions must be based on a foundation of accurate and reliable data. This foundation of data is established by deploying a wide range of tools that can acquire, transform, validate, store, analyze, distribute, and maintain data of all forms and sources.

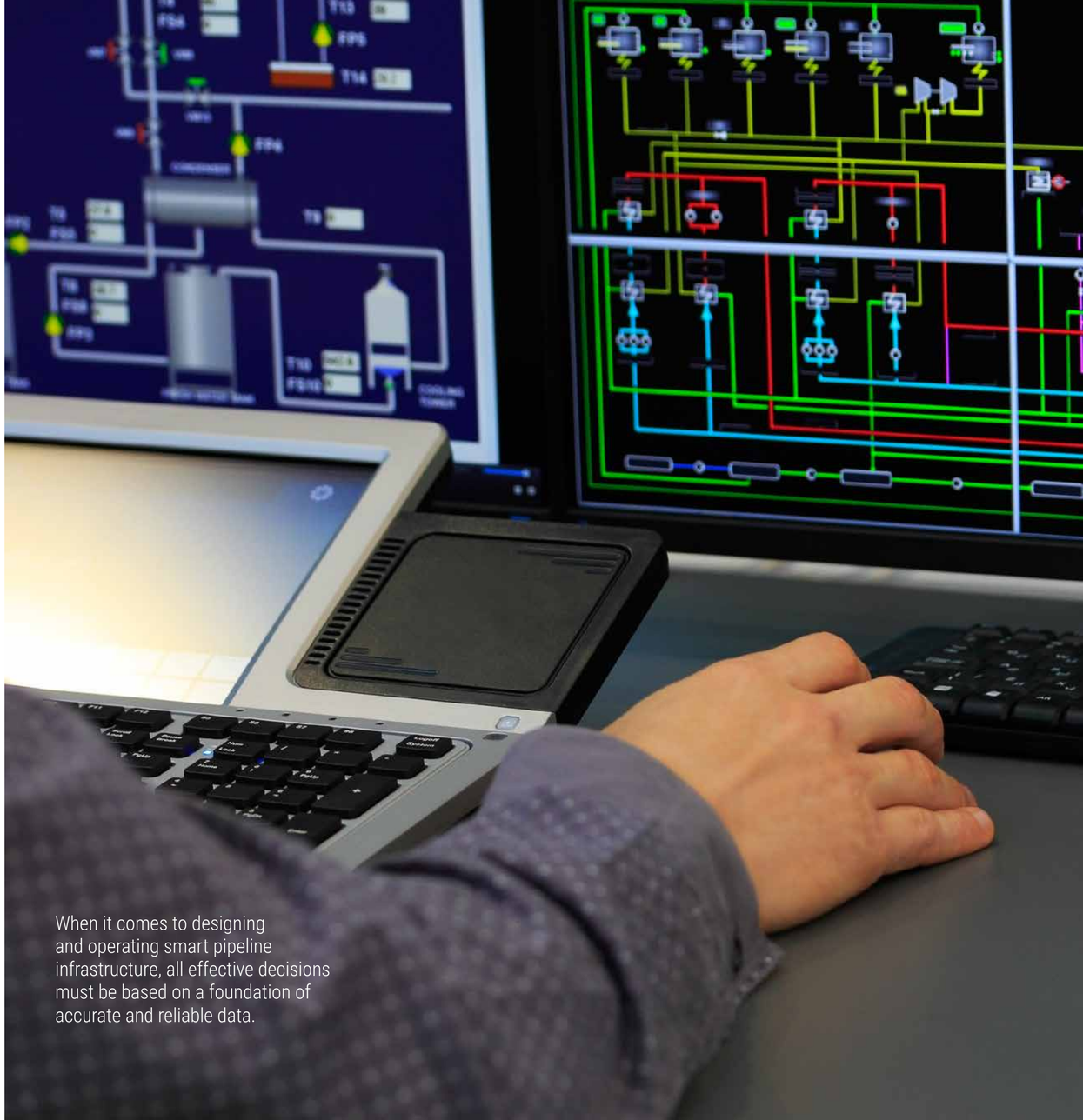
We take our foundation of data and combine it with real-time inputs like operations, land management, and inspection data. This approach provides end-users with the most up-to-date information. This centralized source offers three vital elements for businesses to reduce risks and costs:

Accessibility is critical to collaboration and ensures all groups have the same information on-hand to avoid communication breakdowns or gaps in knowledge.

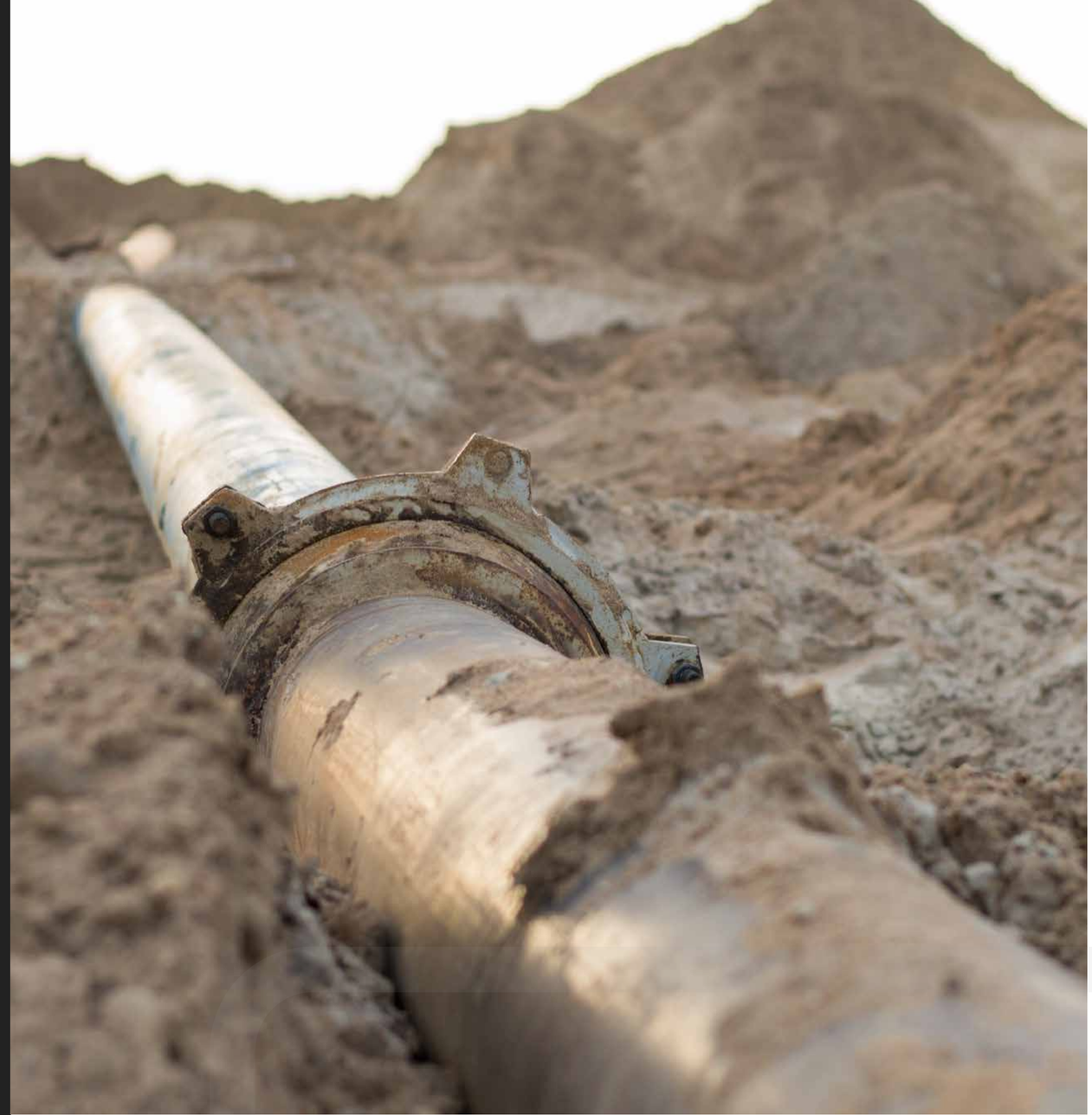
Reliability allows for stronger decision-making processes and lessens the need to constantly backcheck data.

Timeliness of data builds efficiency across all user groups, offering a real-time data analysis process that contributes to making pipeline infrastructure ‘smart’.

Integrated data offers a more detailed representation of ‘what’ the picture is to a wider audience and enables a better decision-making process. How? By promoting extensive collaboration between functional work groups and enhancing their ability to access the same information. Ultimately, this leads to more rapid and robust decision-making capabilities. >



When it comes to designing and operating smart pipeline infrastructure, all effective decisions must be based on a foundation of accurate and reliable data.



02 GEOLOCATION: IT'S ALL ABOUT THE 'WHERE'

Much of today's data is based upon spatial information. Many applications tailor information to you based on your location and proximity to other elements. It's all about the 'where', and that is fundamentally governed by Geomatics.

The same spatial data used in smartphones and other devices is now helping the Oil & Gas industry. From tracking nearby construction projects to managing vegetation growth in pipeline right-of-ways, the 'where' often provides the linkage between unique datasets that can exist in different operational work groups. This generates a bigger picture and compounds the knowledge base.

Implementing spatial data—or the 'where'—also offers lifecycle efficiencies regarding pipeline threat detection, response planning, active maintenance, and monitoring. Our data management solutions can provide our clients with the 'what' and the 'where' faster than other conventional methods. >

> "Our data management solutions can provide our clients with the 'what' and the 'where' faster than other conventional methods."

03 ANALYTICS: DELIVERING SMART, DATA-DRIVEN PIPELINE INFRASTRUCTURE

There are more than 3 million miles of pipeline infrastructure in North America—and its aging by the day. To stay ahead of the curve, operators are required to analyze large volumes of data to monitor pipelines, identify threats, and initiate corrective measures, if needed. Powerful data management solutions generate these overlapping data elements and closely align with essential pipeline integrity processes.

For example, let's consider a pipeline integrity engineer who identifies an external corrosion feature on an active pipeline. If the engineer applies this data with historical information, he/she can highlight a break down in pipeline coating. The geolocation data defines where the repair should proceed. But it can also be further analyzed against crossing features and depth of cover information to provide further insights into site conditions when planning excavation.

Why is this important? Because the intersection of data can determine if the repair is under a road or waterway, if it's adjacent to foreign lines, and how much excavation is required for a fix. It may also include right-of-way information to aid in notifications and crossing agreements. The deeper the data, the greater the analytical capabilities—saving significant time and money and proving pipeline integrity data management solutions are key to monitoring our aging infrastructure. >

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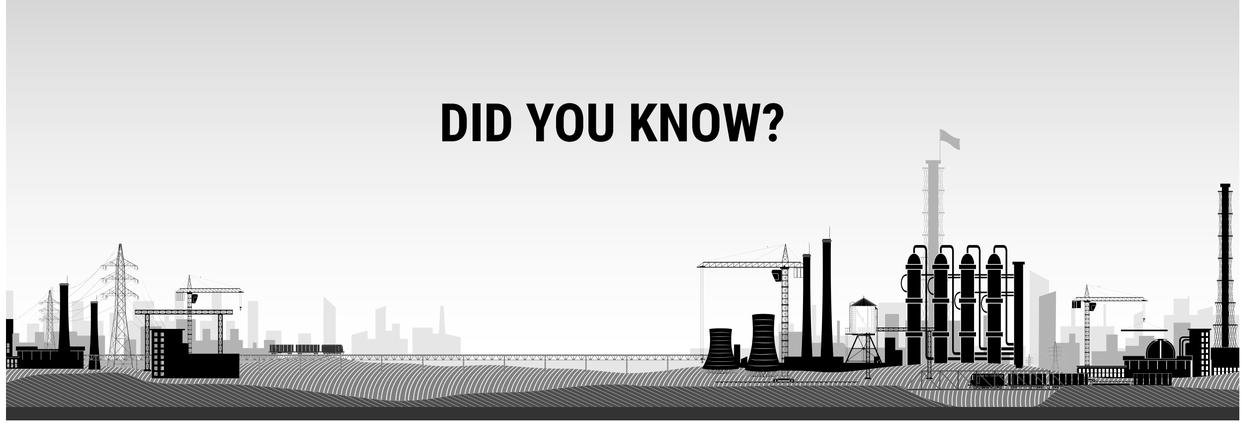
DID YOU KNOW?



> "In North America, millions of miles of pipeline infrastructure is used every day to safely and efficiently move energy and raw materials."

3 million+ miles
of pipeline infrastructure in North America

Transporting existing capacity of 300,000 barrels would take:

1 pipeline	**1,400 tanker truckloads**	**441 tanker railcars**

Source: www.transmountain.com/project-overview

DATA LEADS TO SAFE DELIVERY

Data can change how Oil & Gas providers deliver their products. By instituting a pipeline data management solution, operational teams have the integrated information required to actively detect and prevent threats, monitor operations, and conduct essential response planning.

By monitoring a pipeline's health, proactive steps can be taken to ensure an operator can measure, evaluate, and manage their risk. In general terms, risks are at the confluence of likelihood and consequence—both of which are identified using large volumes of data.

The likelihood of failure analyzes engineering and monitoring data in alignment with external threats such as terrain, crossings, and adjacent construction works. The results are then correlated to potential consequences, which take into account diverse information pertaining to population, terrain, environmental concerns, and historical geospatial information.

Pipeline operators are actively seeking new ways to minimize risk. Risk to operations, stakeholders, environment, reputation, and communities. Forward-looking analysis using diverse and aligned datasets is critical to developing safer—and more efficient—operations.

As our way of managing data continues to evolve, so does our ability to effectively monitor aging pipelines across North America. ■

Data is increasingly seen as an asset. It can be used to promote better business decisions, optimize operations and maintenance, and reduce overall costs.

Mark Strickland

Senior Associate, Community Development

Mark is responsible for managing geospatial data projects based in the energy sector. Driven by improving processes to get better results for his clients.

Dennis Zadery

Vice President, Integrity, Oil & Gas

Dennis is responsible for helping clients maintain safe and reliable systems in sectors like Oil & Gas. A sought-after specialist in integrity management program development and engineering assessments.

MORE FOR YOU →

When was the last time your mine had a check-up?

LEARN MORE
ABOUT PIPELINE INTEGRITY

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When was the last time your mine had a check-up?

Mine safety, efficiency, and profitability rely on a continuous investment in mine infrastructure.

BY CHAD TOMLINSON AND TIMO TIKKA

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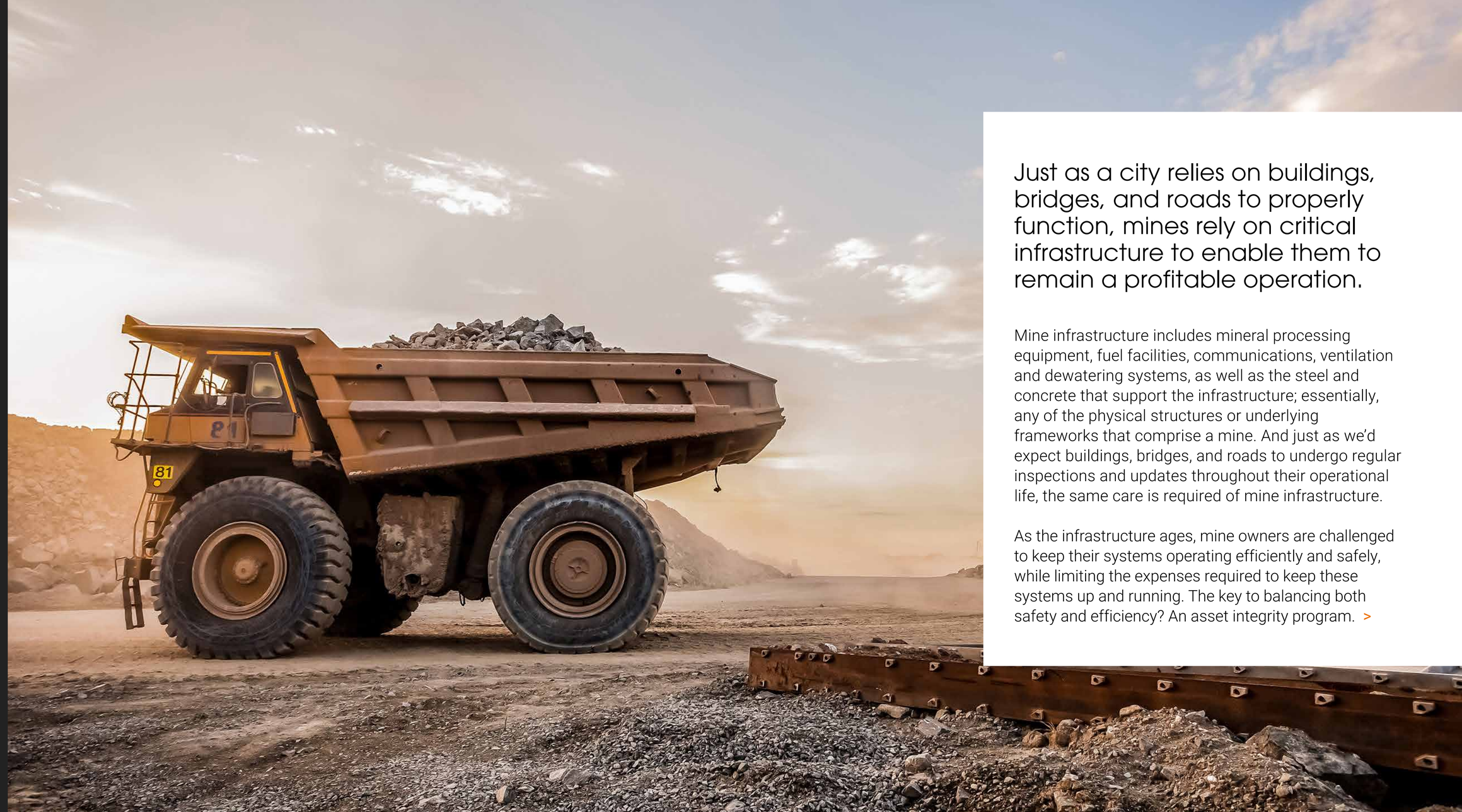
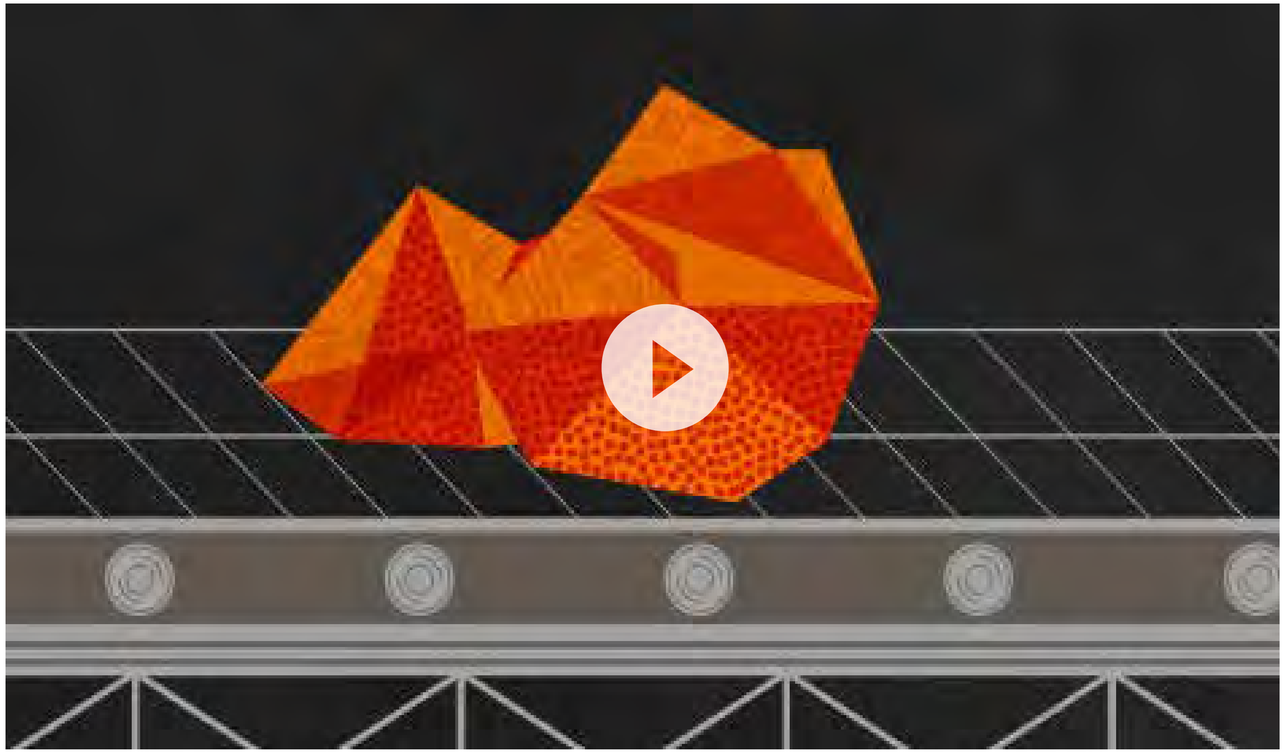


Just as a city relies on buildings, bridges, and roads to properly function, mines rely on critical infrastructure to enable them to remain a profitable operation.

Mine infrastructure includes mineral processing equipment, fuel facilities, communications, ventilation and dewatering systems, as well as the steel and concrete that support the infrastructure; essentially, any of the physical structures or underlying frameworks that comprise a mine. And just as we'd expect buildings, bridges, and roads to undergo regular inspections and updates throughout their operational life, the same care is required of mine infrastructure.

As the infrastructure ages, mine owners are challenged to keep their systems operating efficiently and safely, while limiting the expenses required to keep these systems up and running. The key to balancing both safety and efficiency? An asset integrity program. >



What an asset integrity program looks like

At its core, asset integrity is a condition assessment: inspecting the infrastructure to determine whether it's enabling the mine to operate correctly and efficiently, and putting proactive measures in place to ensure it continues to operate as desired; and if it's not operating as desired, determining what actions are necessary to resolve the problem.

This also serves as a health and safety risk assessment to ensure that the asset is safe for workers to use and to protect the owner from future liability (for example, inspecting railing and guarding systems). The assessments can encompass everything from visual inspection, structural/mechanical analysis, and material testing, to 3D laser surveying and prototype development.

There are five essential goals of an asset integrity program:

1.

Evaluate the integrity of critical equipment and infrastructure (system components) in the operation

2.

Take preventative action to keep the infrastructure in working order (coating, cleaning, pipe rotation, etc.)

3.

Identify critical system components that need replacement or significant upgrades

4.

Develop annual sustaining capital and operational budgets that consider critical system component upgrades

5.

Allow early planning and budget authorization to execute these projects during the year required

This entails thorough yearly, monthly, and sometimes even weekly inspections of systems and equipment to ensure they are functioning properly. Most countries have regulations regarding how often inspections should be conducted, although the level of regulation varies from country to country. However, mine owners will find it valuable to build out a program that specifically identifies critical infrastructure for their operation and optimizes the inspection and preventative maintenance programs. >

Why an asset integrity program is essential

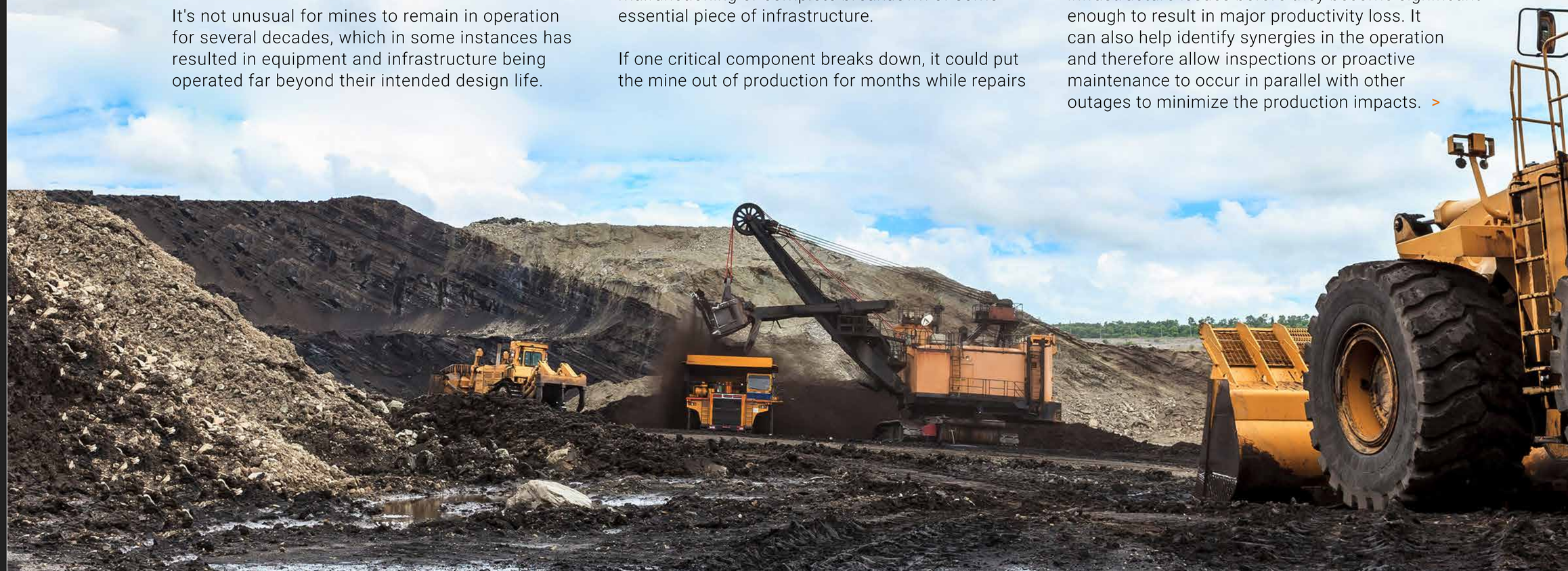
It takes a significant effort and commitment to continually maintain infrastructure in its most optimal condition. Shutting critical infrastructure down for preventative maintenance has an impact to the production and revenue of a mine. However, since the loss and downtime after failure is often far more substantial, it is highly beneficial to take a proactive approach.

It's not unusual for mines to remain in operation for several decades, which in some instances has resulted in equipment and infrastructure being operated far beyond their intended design life. Therefore, the longevity of mining operations makes it critical to have an asset integrity program in place."

Waiting to update or replace the outdated infrastructure once it breaks down can have disastrous consequences. Serious mining accidents and fatalities can and have occurred due to the malfunctioning or complete breakdown of some essential piece of infrastructure.

If one critical component breaks down, it could put the mine out of production for months while repairs are conducted. The breakdown could potentially cause damage in other areas of the mine as well, resulting in even longer production delays.

Establishing a comprehensive asset integrity program early in the life of the mine will provide long-lasting financial benefits. Proper planning can allow mine owners to anticipate and address infrastructure issues before they become significant enough to result in major productivity loss. It can also help identify synergies in the operation and therefore allow inspections or proactive maintenance to occur in parallel with other outages to minimize the production impacts. >



Jansen Potash
Saskatchewan

Internal vs. external programs

Equally important as having an asset integrity program in place is determining who will be responsible for executing the program. The proficiency of the technical experts who conduct the inspections and make the recommendations for changes will ultimately determine the program's effectiveness. Whether a mine owner chooses to hire an external consultant or dedicate an internal team to the task, the audit of mine assets requires dedicated resources that are not focused on the day-to-day operations of the mine.

Typically, staff directly employed by the mine are focused on daily operations of the facility to meet production goals and often do not have the necessary availability to support these types of robust programs. Furthermore, these tasks are best performed as a "pit stop approach" by using several resources during outages to cover as much critical equipment as possible. By leveraging independent resources, mine operators can rely on them to initially develop asset integrity programs and provide support to their staff without distracting them from other areas for these efforts. Additionally, they can provide unbiased evaluations and focus on identifying system components that require upgrades or replacements. They can also draw on their experiences at other operations to provide new solutions and ideas.

As the mining industry moves toward an enhanced culture of safety and reliability of assets, mine owners will find it beneficial to retain the services of experienced professionals with an existing asset integrity management culture and structure in place. >

Nickel Rim South Mine
Ontario

Be proactive, not reactive

Consider how we systematically care for our cars and bring them to auto shops for inspections; we do this as a preventative measure. Although the upfront time and costs associated with these efforts can sometimes be daunting, we recognize that long-term benefits are worth the short-term inconveniences. Similarly, mine owners could see significant financial benefit and increased reliability in developing a robust asset integrity program. Reducing the potential for a catastrophic failure that could significantly impact production, or worse, pose substantial risk to worker health and safety, will be worth it in the long run. ■

Chad Tomlinson

Senior Consultant

Chad has spent more than two decades working in the fields of civil and environmental engineering. As principal engineer and leader of the US southwest mining team's civil engineering group, he's led numerous projects to improve the safety and efficiency of mining operations.

Timo Tikka

Senior Consultant

Timo has extensive experience in structural engineering design and managing large capital projects. He's spent four years working as a civil engineering technologist on several large-scale construction projects, taking on the duties of construction supervision, surveying, inspecting, and drafting.

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Refurbishment to our hydropower stations will pay off long term

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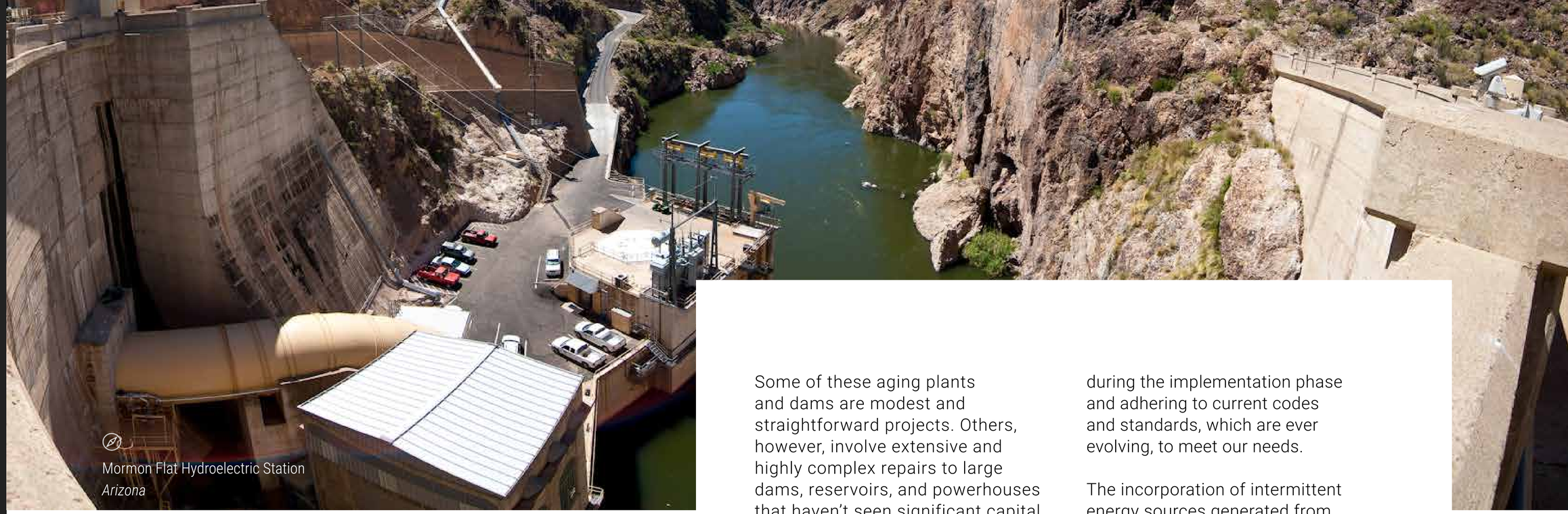
Updating our Hydro&Dams

Updating and refurbishing our hydropower stations will pay off long-term

Over the last decade or so, hydropower refurbishments have become a large part of the world's energy practice. Many utilities in the United States own hydro fleets built in the post-war period that are now reaching the end of their lifecycle.

BY DON ERPENBECK



Mormon Flat Hydroelectric Station
Arizona

ACCORDING TO THE AMERICAN SOCIETY OF CIVIL ENGINEERS, NEARLY 2,000 DAMS IN THE UNITED STATES WERE LISTED AS BEING IN NEED OF REPAIR IN 2017. TODAY, 70% OF THE DAMS IN THE UNITED STATES ARE MORE THAN 50 YEARS OLD.

Some of these aging plants and dams are modest and straightforward projects. Others, however, involve extensive and highly complex repairs to large dams, reservoirs, and powerhouses that haven't seen significant capital improvements in decades.

High-hazard dams are of particular concern. At the time they were built, these dams were designed to withstand extreme weather events. However, as these events have intensified throughout the decades, dams demand more and more maintenance, including upgrades and refurbishments. Furthermore, taking on a refurbishment project means understanding the risk process during the implementation phase and adhering to current codes and standards, which are ever evolving, to meet our needs.

The incorporation of intermittent energy sources generated from wind and solar has placed additional strain on hydrogenating stations, which must be turned on and off far more frequently to accommodate fluctuating power flows. The evolution of design criteria, as well as new navigation, environment, and water management regulations, have caused utilities to undertake massive refurbishments to hydropower dams at century-old locations. >

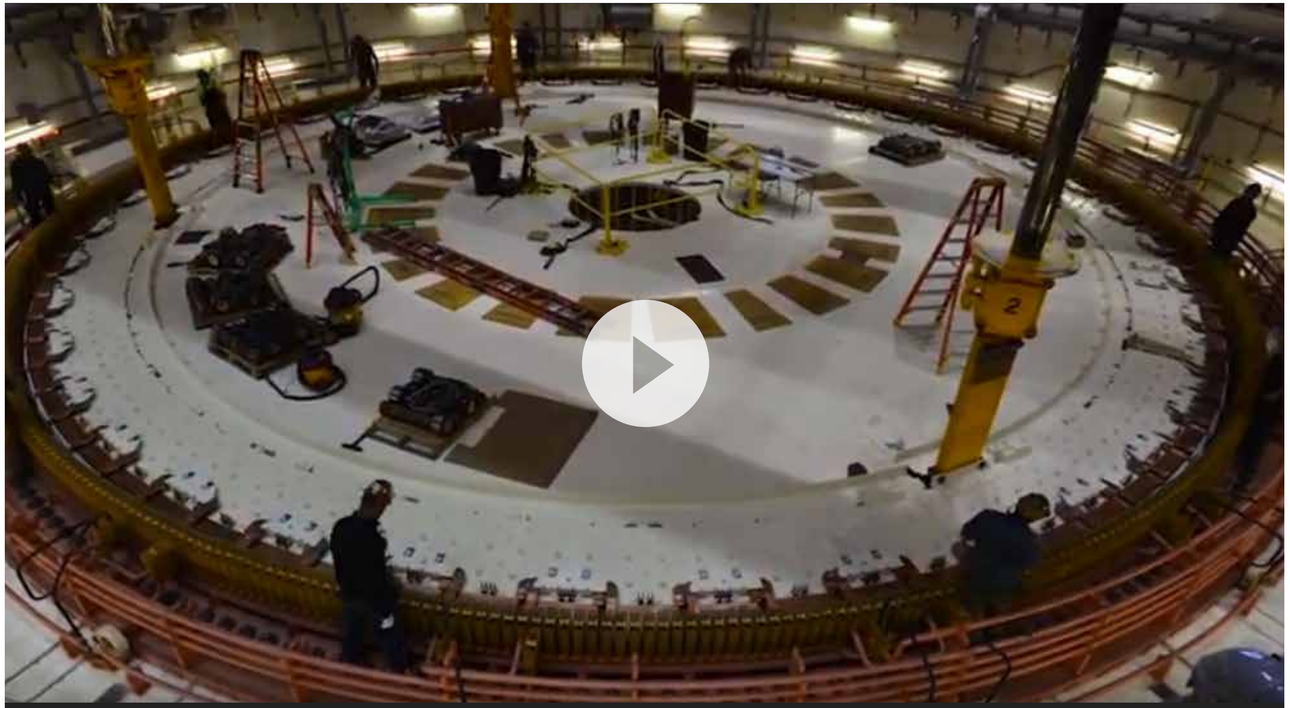
UNDERSTANDING AGING HYDRO COMPONENTS ARE KEY TO REFURBISHMENTS

Engineering challenges are tough and require a deep, systemic understanding of not just current hydroelectric design standards, but the performance and quirks of aging components, like valves, that may have been installed decades ago.

The risks associated with doing nothing too high. The problem is well understood, but the solutions are expensive and difficult to implement.

Examples of aging infrastructure can vary widely. For example, A 50-year-old dam in Eastern Canada was build with concrete with a chemical composition that has expanded steadily, substantially reducing the anticipated lifespan of the spillway.

In another case, we provided planning, project management and construction management, for the complete overhaul of turbines and generators at the almost 80-year-old Grand Coulee Hydropower Plant, a large hydro facility owned by US Bureau of Reclamation, on the Columbia River in Washington state. When all upgrade are finished, the entire project is predicted to cost more than $100 million.



↑ *Turbine upgrade at the Grand Coulee Hydropower Plant, courtesy of the US Bureau of Reclamation*

While most of these hydropower refurbishment projects are commissioned by utilities that have realized the need to address long-recognized aging processes, others have come out of left field.

A utility employee in Columbia was driving on the roadway over a looming dam when he noticed a strange kink in the roadbed. When the Utility's engineers came out to inspect the site, and soon realized that the concrete dam itself had shifted enough to warp the road, a situation that raised alarm bells about the risk of a collapse.

This sort of sudden infrastructure issue can be difficult for clients to absorb. Such refurbishments involve substantial cost and offline time, and, as in the case of the warped dam, may require multi-staged repairs—initially to stabilize the asset and then to develop a sustainable long-term solution.

We perform what amounts to triage, which involves a root-cause analysis and a proposed course of action to mitigate risk. We regard this sort of up-front advisory role as critically important, and always make sure we're bringing the most experienced people on our team to provide insight. >

Image courtesy of the US Bureau of Reclamation

REVERSE-ENGINEERING CENTURY OLD EQUIPMENT

From my earliest days as a young mechanical engineer working for the Tennessee Valley Authority, I learned that hydroelectric dams must be viewed as highly interconnected systems, not just a set of mechanical and concrete components. The facility, depending on its age, may be highly calibrated to equipment that has long gone out of production.

Not long ago, we were brought in to assess a hydro station where a large valve had been installed as part of an overhaul of the penstock, the intake structures that control water flow. When the utility tested the new equipment, the entire facility began to shake violently.

As we looked more closely at what had been done, it became apparent that the original valve was a ring follower gate[4], which dated back to a design developed in the 1930s by the US Bureau of Reclamation for the Hoover Dam. To properly fix this station, we needed to reverse engineer the original equipment in order to replace it with something that worked in tandem with the rest of the system.

RESPONDING TO AGING INCIDENTS MEET OUR IMMEDIATE AND LONG-TERM NEEDS

These incidents highlight the need for us to invest in the infrastructure behind the energy. The fact that hydropower is the nation's largest renewable electricity resource, providing 7% of our total generation, should make prioritizing its aging infrastructure a no-brainer. When we begin this process with risk-based studies, we can ensure better budgeting and more sustainable solutions for the future. The actions we take now will ensure our infrastructure is ready for the next extreme event, while these plants continue to serve us quietly day in and day out.

By studying the structures of the past, and responding to current and future incidents, we are not just meeting our immediate needs, but the needs of those to come. We are giving future generations the same opportunity for success. ■

HYDROPOWER IS THE NATION'S LARGEST RENEWABLE ELECTRICITY RESOURCE, PROVIDING 7% OF OUR TOTAL GENERATION

Don Erpenbeck

Vice President and Global Sector Leader, Power & Dams

With more than 20 years of experience in the hydropower industry, Don has a diverse background in engineering and project management on projects throughout the world, with a specialized expertise in hydropower rehabilitation and pumped storage projects of all sizes.

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Monitoring pipelines from space

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ABOUT HYDROPOWER REFURBISHMENT

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MONITORING PIPELINES FROM SPACE

Understanding where and when a pipeline leak has occurred via satellite technology

Energy & Resource projects come with their own set of arduous challenges before, during, and after the construction process. Maintaining the integrity of these projects throughout their lifecycle is critical, particularly when it comes to Oil & Gas pipelines.

BY GRANT WISEMAN AND BRENT KADLER

If a pipeline leak occurs, it can have several environmental, social, and economic impacts for pipeline operators and the communities they serve.

Leaks can harm the natural environment as well as the wildlife living in it. They can impact the safety of surrounding communities in the area. Leaks can also cost pipeline operators their time, money, and ability to compete for work. That's why we employ measures to safeguard the Oil & Gas industry against the risk of pipeline leaks.

Thanks to innovation, many new pipelines have the luxury of built-in technology that digitalizes operations and maintenance via fiber optic cables. But many of the pipelines we need to monitor are already in the ground—some have been buried for more than 50 years!

Traditionally, pipeline operators have monitored buried pipelines via ground or aerial patrol, examining the land for any visible changes to the earth. But those methods can be timely, costly, and sometimes ineffective—especially because pipeline leaks require urgent action to minimize impact to the surrounding environment.

NOW THE INDUSTRY IS TURNING TO REMOTE SENSING, SATELLITE IMAGERY, AND TOOLS LIKE PIPEWATCH TO HELP THEM FIND LEAKS MORE EFFICIENTLY.

PipeWATCH can quickly help mitigate surface and subsurface releases by pinpointing exact locations of concern.

Remote sensing to monitor aging pipeline infrastructure

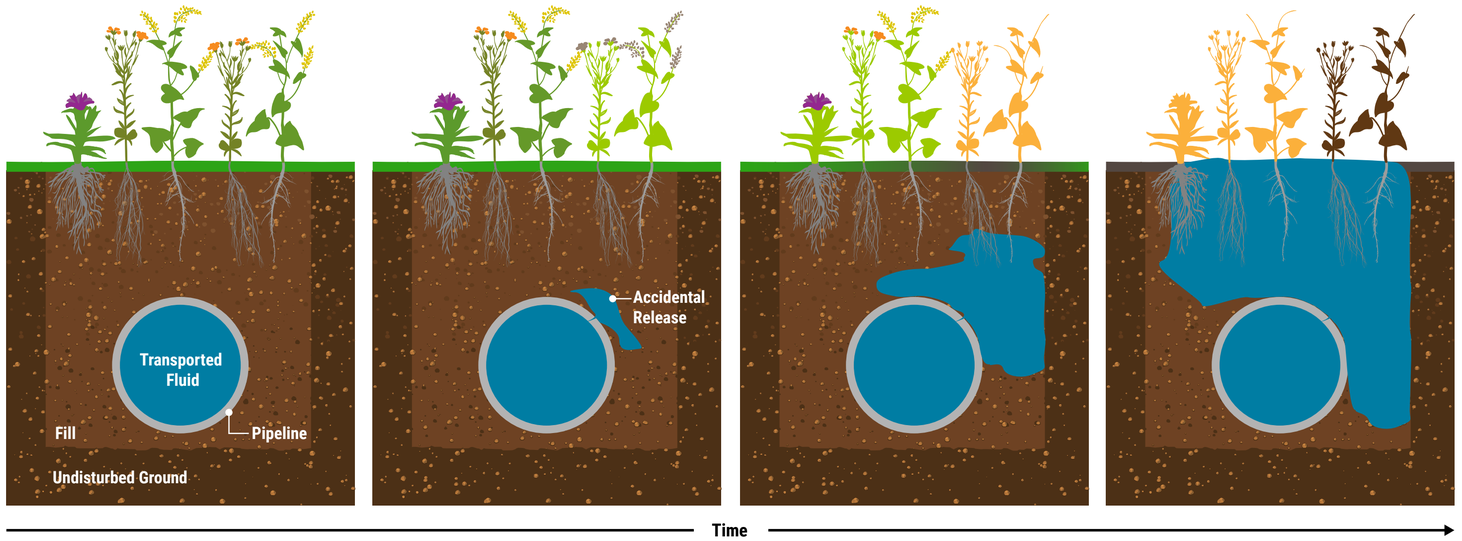
Remote sensing specialists work to analyze images captured above Earth's surface. Why? To give our clients a deeper understanding of our planet and how it changes over time.

In recent years, remote sensing specialists have relied on satellites orbiting the globe to take photos of Earth continuously throughout the day. We use this imagery to better understand the environment and make more informed decisions about almost anything related to the surface of Earth. Now, we use this satellite imagery to help monitor aging pipeline infrastructure for leaks.

In the past few years, remote sensing technology has evolved significantly. Thanks to the development of small, inexpensive satellites, we can now capture and examine images of the entire planet each day. These technological advancements have enabled Stantec to create PipeWATCH, a revolutionary remote sensing tool that helps us effectively monitor buried pipelines. >

Shots from space

PipeWATCH is made possible by the power of small satellites, called Dove satellites, and their ability to take high resolution images of the Earth's surface. Traditional satellites are as large as a truck but small satellites are less than the size a microwave. Rather than one big satellite, dozens of small satellites are launched into orbit and arranged in constellations, enabling them to capture more images at a higher resolution.



HEALTHY PIPELINE
Before any pipeline leak occurs, the fluid is contained within the pipe and the vegetation remains healthy.

SATELLITE DETECTION
When a pipeline leak occurs, PipeWATCH can detect early changes to the health of the vegetation.

FIELD DETECTION
When a leak goes undetected until ground crews find it, more of the fluid is released into the soil and damage to the vegetation becomes visible upon up close inspection.

AIRCRAFT DETECTION
When a leak goes undetected until an aircraft picks it up, the fluid is forced upwards to the surface, with the health of vegetation suffering greatly.

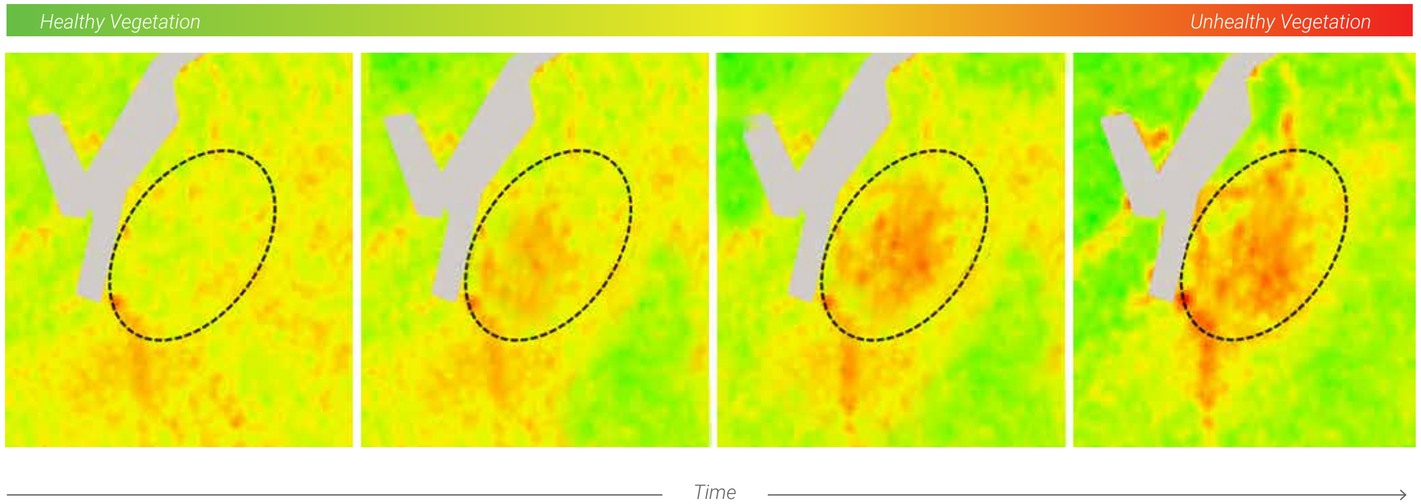
These small satellites acquire red, green, blue (RGB) and near-infrared (NIR) images to monitor vegetation that is growing above and around buried pipeline infrastructure. PipeWATCH then calculates highly sensitive vegetation health measurements on the pipeline right-of-way (ROW). Using change detection analysis, PipeWATCH compares ROW vegetation health values from one day to the next, looking for signs of reduced vegetation health.

A decline in vegetation health on a pipeline ROW could be caused by a release event.

Thankfully, PipeWATCH knows what patterns to look for and can analyze vast sets of images almost instantly. When we notice a significant change to the vegetation, we know that a leak may have occurred, and that action must be taken. The beauty of PipeWATCH is that it provides this information to us much faster than any other method! >

CASE STUDY

Captured by small satellites orbiting the globe, RGB images reveal changes to the health of vegetation near pipeline routes. When we notice the color shifting from green to red, we know that a leak may have occurred. As time passes with a leak going undetected, there will be more damage to the vegetation. The bigger the leak, the quicker the vegetation will experience a reduction in health.



When a pipeline operator approached us to prove the effectiveness of our trusted tool, we were eager to demonstrate it for them. They had been interested in PipeWATCH for some time, but they needed proof that the technology actually worked. So, they presented us with a pipeline leak that they had experienced earlier that year. They gave us a four-month time span and a 625-square-kilometer area to analyze—that was it! We had to use PipeWATCH to ascertain the rest.

The test for our team was to determine exactly where and when the spill had occurred in that four-month window. PipeWATCH can look back in time—via a historical satellite imagery archive—to study images that were taken in the months prior. The result? We established that the spill happened five days before our client had even realized it. Had they used PipeWATCH, they could have responded to the leak five days earlier, giving them more time to mitigate any environmental, social, or economic impacts.

"IN THE PAST FEW YEARS, REMOTE SENSING TECHNOLOGY HAS EVOLVED SIGNIFICANTLY. THANKS TO THE DEVELOPMENT OF SMALL, INEXPENSIVE SATELLITES, WE CAN NOW CAPTURE AND EXAMINE IMAGES OF THE ENTIRE PLANET EACH DAY. "

Proving the power of PipeWATCH

PipeWATCH isn't just able to tell us whether a leak exists; it can accurately tell us when and where it happened.

Thanks to our formal partnership agreement with Planet—the world leading satellite imagery provider—we can offer pipeline operators unprecedented satellite image fidelity and consistency. Our ability to access this data allows us to review images taken in real time to help us understand exactly when and where a leak is occurring. >

PipeWATCH technology continues to evolve

Currently, the small satellites that PipeWATCH uses take images at a resolution of three metres per pixel. This is a significant improvement from two years ago, when we were only able to monitor Earth's surface to a resolution of 10 meters. The technology is continually getting better, and by the end of 2020, we expect to look even closer at the surface of Earth with a resolution of 50 centimeters per pixel. This trend of greater and greater resolution will continue—we are striving for a 25-centimeter resolution by 2022.

As our ability to track changes on the surface of the earth improves, so does our ability to monitor aging pipeline infrastructure for the Oil & Gas industry and the communities it serves. ■

Grant Wiseman

Geomatics Remote Sensing Specialist

Grant has completed studies across the globe, from the rainforests of central Borneo to the arctic territories of northern Canada. Utilizing many types of remotely sensed imagery, Grant is always findings ways to bring his expertise to new markets.

Brent Kadler

Oil & Gas Project Engineer

Brent has more than 15 years of experience in delivering large industrial projects in Alberta. Applying new technologies and rapidly removing roadblocks, Brent is always looking for synergies between industries to improve the bottom line.

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Investing in our past to create a clean energy future

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STANTEC era

ENERGY & RESOURCES ADVISOR

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Technical Editors: **Dave Bernier, Mario Finis, Pat Poelzer, and Jon Treen**
Layout and Design: **Vanessa Rosentreter-Liang**
Special Thanks: **Andrew Wedman and Amber Zahler**

Data sources used for Stantec Era:

[1] American Society of Civil Engineers
[2] Race to save our planet
[3] The cleaner 'bridge' fuel
[4] Follower gate