October 2017

Clarity from above

Leveraging drone technologies to secure utilities systems

$169 billion

Global cost of power & utilities sector losses related to network outages

$609 million

Revenue opportunities related to improving reliability of power supply systems

pwc

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Contents

How is technology reshaping the power & utilities sector?

In May 2016, PwC's Drone Powered Solutions team released our first global report, *Clarity from above*, on the universe of commercial applications of drone technology. The purpose of that report was to present emerging commercial applications of drone technologies, a global overview of regulatory frameworks and the estimated addressable market value of global drone powered business operations across key industries. In December 2016 we published the first of a series of sectoral reports, which discussed in detail the opportunities for drone technologies in transport infrastructure. Subsequently, in July 2017 we released a report on the telecoms industry, which focused on creating new revenue streams for telecoms operators through the implementation of new technologies.

Today, we continue our series of *Clarity from above* reports with a publication regarding drones and new technologies in another sector with huge potential: power and utilities.

The power and utilities sector is on the verge of a digital revolution and faces numerous new challenges. Due to increasing social pressure to shift from fossil fuels to renewable energy sources, while simultaneously bringing energy prices down, the sector is trying to find new ways to maintain profitability. Existing business models are being disrupted by the growth and decarbonized generation and the popularity of electric vehicles. Both trends are shaping how energy is produced, distributed and consumed, and are forcing industry players to reinvent their business models. Technology development is enabling already well-proven innovations such as drones and digital technologies to be harnessed in order to increase the reliability of producing, transmitting and distributing energy. At the same time it is helping to bolster cost efficiency and to streamline maintenance and management processes.

The only limitations lie firstly in choosing the most suitable technologies to meet companies' current and future needs, and secondly in applying them in a way that achieves the most desired outcome.

The purpose of this report, therefore, is to offer some insight into the existing technological capabilities of drone applications relevant to the power and utilities sector. We hope you'll enjoy reading *Clarity from above: Leveraging drone technologies to secure utilities systems.*

Michał Mazur
Partner, Drone Powered Solutions

Adam Wiśniewski
Director, Drone Powered Solutions

1. What are the key market trends?

The power & utilities market includes electricity and water management companies operating in production, transmission and distribution segments. Although all segments are driven by similar trends, there are still significant differences in how these trends affect the market situation, the competitiveness level of the industry and companies' operations. The global power & utilities market has been driven by growing demand for energy supply as a result of urbanisation and growth in population and technology use. Other major trends include the transition from fossil fuels to clean energy, regulatory pressure to bring energy prices down and technological innovations disrupting existing business models. In the water industry, it is becoming increasingly important to develop pollution prevention strategies and manage wastewater, as well as prevent leakages in pipelines and drainage channels not to waste water, especially in areas where it is scarce.

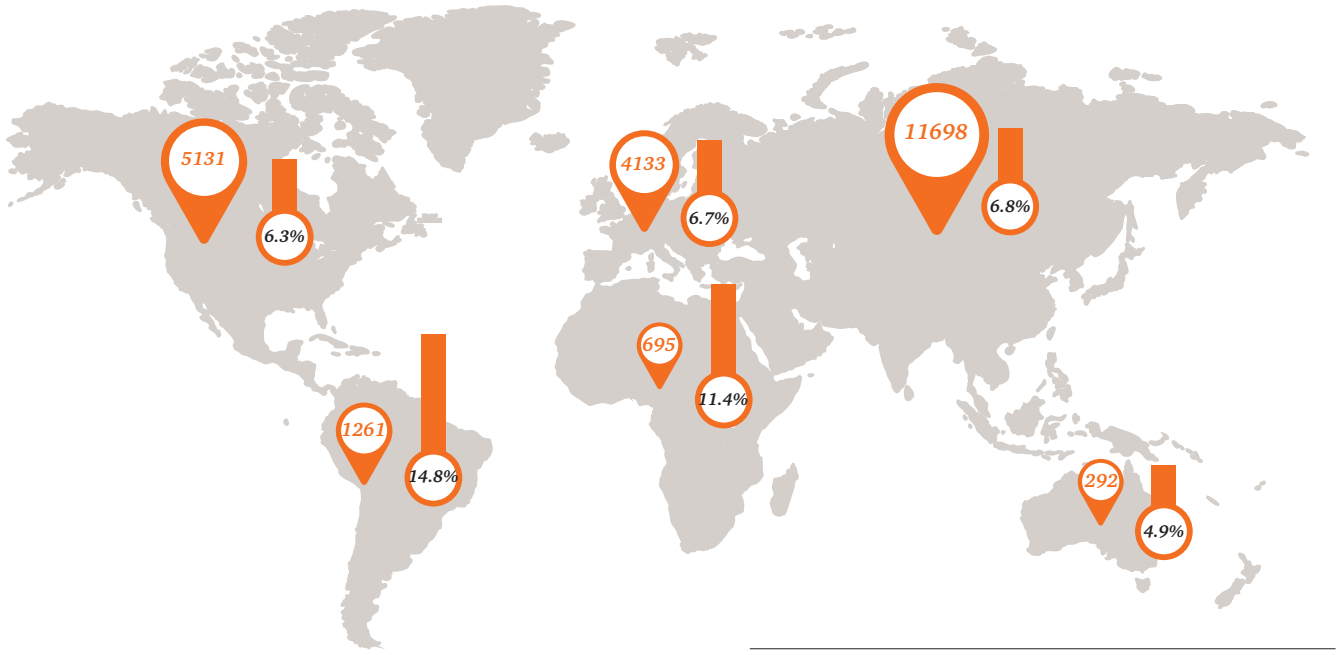
In the P&U production segment, valued at around USD **2.357 trillion globally**[1], this will lead to new capital-intensive projects to build new power generation infrastructure. While traditional energy sources (coal, oil, gas) retain their lead, renewables are gaining popularity and market share, especially thanks to rapidly decreasing costs of energy production from solar and wind farms. The transition to clean energy sources will result in the creation of a decentralised energy production system, consisting of many household mini power plants instead of a handful of massive, conventional plants feeding power into the network.

The same trends will influence the P&U transmission & distribution segments, requiring that industry players guarantee the stability of power flow through a complex, interconnected system of traditional power plants, transmission lines and renewable energy plants.

The global length of power transmission lines, currently **5.9 million circuit kilometres, is expected to reach 6.8 million circuit kilometres in 2020.**[2] This growth in the length of power transmission and distribution infrastructure will be driven by the reshaping of the P&U production sector as well as by China, India and other emerging markets increasing their energy demand.

Reliability of supply is an important consideration, especially in countries where energy prices are regulated. If power utilities are able to reduce the frequency and duration of outages they can receive better pricing outcomes from regulatory authorities, and avoid penalties from failing to meet reliability standards. While globally energy prices are expected to decrease, players in the power & utilities industry must especially work towards minimising outages of transmission and distribution infrastructure. It is also worth mentioning that the rapidly changing environment as a result of global warming will cause more natural disasters than ever before, which will become a major challenge for securing electricity supply.

The amount of electricity production by regions in 2016 (TWh) and % of electric power and distribution losses



Source: World Bank, CIA World Fact Book, PwC Analysis

[1] Source: WorldBank, CIA World FactBook
[2] Source: ReportsnReports, PwC Analysis

Drone technologies

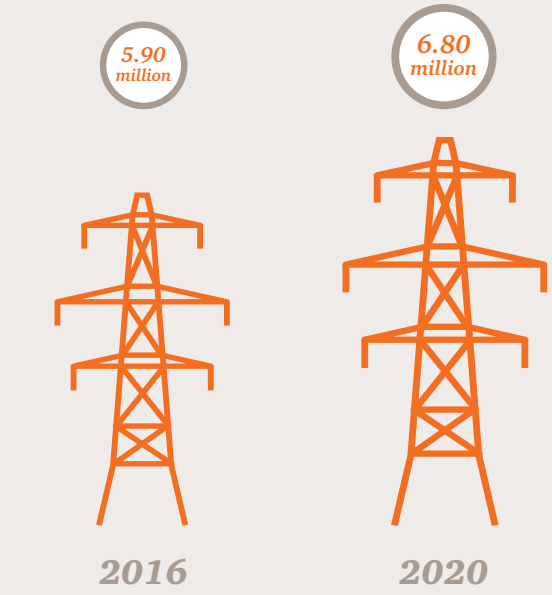
New technologies such as drones create a whole array of new opportunities for companies involved in both the energy production sector and the transmission or distribution sectors, as well as for companies involved in water industry. UAVs (Unmanned Aerial Vehicles) can be used in monitoring and maintenance of all types of power & utilities production facilities, and thanks to special sensors, they not only capture the current state, but also provide analysis of numerous factors influencing operation of the facility. PwC estimates the addressable market of drones powered solutions in the power & utilities market at **USD 9.46 billion.**[3] Drones can live-stream high-definition or infrared video, as well as take detailed high-resolution images, which are later processed to photogrammetry products. For instance, a thermal camera may help identify overheating parts of infrastructure, or spots that require further action. Analysis can be performed on multiple types of infrastructure – e.g. energy towers (poles), water management infrastructure, wind farms and photovoltaic panels.

The potential of drones to assist in maintaining power & utilities networks is even greater. Maintenance of assets spread across a vast area, accessing hard-to-reach infrastructure and execution of dangerous inspection procedures normally performed by humans, or by expensive helicopter or airplanes, can all be replaced by drones. UAVs beat other technologies by making inspections cheaper, faster and safer. They also allow greater precision and better access to hard-to-reach places. Predictive maintenance, focused on minimising network failures and damage, is also of great importance. Most importantly, drone-based inspections can be performed without having to halt the power supply. Such advantages are crucial, as more and more countries are implementing regulations awarding financial incentives to companies that improve reliability or imposing penalties on those that fail to meet targets. PwC has calculated the global value of incentives related to improving reliability of power supply systems at **USD 609.3 million.**[4]

Benefits from implementing drone technologies are applicable to companies involved in water industry as well. Water technology companies can find major opportunities in introducing innovative and cost effective solutions such as drones to monitor water quality. As governments and regulators put increasing pressure on developing pollution prevention strategies and managing wastewater, effective data collection regarding water quality is becoming crucial to meet those demands, as well as continue operating efficiently.

Undoubtedly, implementation of drone technologies in the power & utilities sector, especially in the maintenance process, can help make more of the incentives and savings attainable. However, the choice of a particular drone technology has to be adjusted to specific business needs, as there is a great variety of technologies on offer and their benefits vary. Regulations regarding drone use, as well as potential constraints created by a lack of drone-related regulations, or their limitations, must also be taken into account.

Global length of power transmission lines (circuit kilometres)



Source: ReportsnReports, PwC Analysis

[3] Source: PwC Analysis

[4] Source: Value of total financial incentives for companies which reduce time of power network outages as well as penalties for those who don't meet targets set by regulators

To remain competitive, companies need to perceive new technologies as opportunities, rather than as disruptors that challenge their business models

Norbert Schwieters – Global EU&R Leader Global Power & Utilities Leader

Today, we are on the verge of one of the most important technological disruptions in the last decades. Technological change is blurring lines between industries, shifting the way we see them, and even disrupting how companies start to position themselves in the market. Change powered by industry 4.0 technologies forces companies to rethink their business models and open up for new opportunities, in order to stay competitive in the new, digital economy.

Digitalization influences all industries. Internet of things, robotics, artificial intelligence, machine learning, advanced advanced data analytics, blockchain and finally drones, are only some of the technologies that cause disruption to today's business. The power and utilities sector, being a backbone of the economy and one of the most traditional and rigid industries, is no different and cannot avoid these disruptions either. Demand for electricity is constantly growing due to emerging technologies, urbanization and growing population. Increased popularity of renewables in overall power generation sources also cannot be avoided. In addition, climate change and regulatory pressure to ensure stable access to energy sources for customers, at the same time operating sustainably, is something that players involved in the sector need to take into account.

That's why choosing the most suitable technologies and creating, as well as executing, a proper strategy to implement those technologies into organizations' processes is vital.

Drone technologies, as well as advanced image analytics, have great potential in the sector. Precise data acquired by unmanned aerial vehicles can increase situational awareness, lower costs and improve the safety of staff involved in maintenance or construction of complex utilities systems. It can also contribute to predictive maintenance by fueling highly advanced models with tangible information regarding the current technical condition of assets. A combination of all previously mentioned technologies can bring great benefits to companies, and help them not only in retaining profitability in the changing environment, but also in avoiding regulatory charges related to energy shortages. To remain competitive on the market, and stay current in the changing business ecosystem which is challenged by new technologies, companies from the power & utilities sector need to broaden their horizons. They need to perceive new technologies, such as drones, as opportunities to increase effectiveness, reduce costs and improve internal processes, rather than as disruptors forcing them to challenge the way they have been thinking, and doing their business for years.

2. Drone technology applications in the power & utilities sector

2.1 Pre-construction and investment monitoring

Worldwide demand for energy is growing rapidly, increasing the need for infrastructure. Large transmission and distribution networks require the implementation of new technologies for effective investment management. Emerging technologies such as drones may become a useful tool for monitoring both the pre-construction and the construction phases of investment projects.

Risk identification & management

The planning phase plays a significant role in identifying risks associated with capital projects. Budget shortfalls, schedule overruns and additional costs have always been challenges for power & utilities companies in the delivery of infrastructure projects.

In the pre-construction phase, drones can speed up the design process and detect an investment's red flags more efficiently. When considering the impact of power plants, water management infrastructure and electricity transmission networks on the environment and on local communities, imagery and documentation gathered from drones can provide crucial assessments of the area surrounding a project.

Aerial surveys of construction sites can ensure a high level of safety and health standards. Using drones to monitor locations that may be hazardous for workers can result in the mitigation of safety risks. Drones can identify real dangers for workers and support prevention of accidents and injuries. Early detection of employees breaching health and safety rules can prevent injuries and lethal accidents, and if they do happen, drones help provide detailed documentation for insurance purposes.

Real time monitoring

Another obstacle for the industry lies in monitoring the condition of construction sites; drones offer attractive opportunities for providing day-to-day progress reports. UAVs are able to quickly survey construction sites and deliver data to project managers in real time. Highly accurate orthophotomaps of construction sites make it easy to track changes and progress, and to compare against plans. Application of this technology facilitates scheduling of further work stages and gives warning of delays.

Inspection 1

Inspection 6

Source: PwC Drone Powered Solutions

Cost efficiency

Power & utilities companies today are increasingly turning to drones that offer cost-efficient monitoring of infrastructure investments. Project delays, insufficient engagement by contractors and a growing number of accident-related legal cases may lead to cost overruns. Drone operations can enable energy companies to quickly detect deficiencies and risks associated with investments, allowing rapid intervention and thus minimising additional budget expenditure. Drones also cut labour costs significantly, as aerial operations substitute for dangerous work and replace ground-based teams monitoring construction sites.

Drones are currently being equipped with technology such as thermal imaging cameras and multi-spectral cameras, and the combination of this imagery data along with Machine Learning and artificial intelligence is having a tremendous impact on the maintenance of critical infrastructure

Steve Jennings – UK Power and Utilities Leader

UK utilities are at early stages of adopting drone technology

As with other sectors that are looking into drone technology in the UK, utilities are very much at the early stages of adoption, with several examples reported in the media of specific projects and trials with clear and discrete objectives. As the level of adoption increases, we expect to see more evidence of the accumulation of drone collected data across wider programmes, and tighter integration with other sources of management data. Drones are being used by UK water companies in various capacities to reduce costs and improve safety. Projects are being undertaken to assess the use of drones to inspect cranes, reducing the expense on scaffolding and avoiding the risks from exposure to heights. Digesters, used to treat sewage sludge, require internal and external inspections – in addition to the cost and height risk reductions, the use of drones with these inspections is also reducing exposure to dangerous atmospheres. Another application being explored is the use of thermal imaging cameras for leak detection. Power and gas network owners have typically used cranes, helicopters or scaffolding to monitor the condition of their assets. Increasingly they are turning to drones to take footage of pylons and check compressor stations in locations less suitable for the traditional solutions, such as over built-up areas. Power network operators are reportedly also looking into the potential to use infrared equipment to identify transformer faults.

The use-cases of drones in the future

Drones are currently being equipped with technology such as thermal imaging cameras and multi-spectral cameras, and the combination of this imagery data along with Machine Learning and artificial intelligence is having a tremendous impact on the maintenance of critical infrastructure. We are seeing organisations begin to leverage this powerful combination to produce predictive analytics, providing a powerful perspective and enabling them to seek out and replace damage to critical infrastructure. Just owning drone equipment will not be a differentiator in this scenario – it will be the application of drones-captured image data to innovative use-cases that will allow utilities to gain a competitive advantage.

2.2 Asset inventory & maintenance management

The power & utilities sector is highly capital-intensive due to the significant infrastructure it requires, which has to be maintained and upgraded to guarantee continuous supply of electricity. Unsurprisingly, one of the biggest costs for P&U companies is operating and maintaining infrastructure such as power plants, electrical substations and power lines. Despite incurring all these costs, every year the power & utilities sector loses **USD 169 billion**[5] due to energy network failures and forced shutdowns. Innovative organizations might find that the ongoing digital transformation and emerging technologies such as drones offer dedicated solutions to address their maintenance and asset inventory issues.

Large asset dispersion

The vast majority of energy infrastructure operators have to manage assets scattered over a large area, located often in hard-to-reach places such as mountains or deserts. As processes inside those companies become digitalised, asset management software such as a digital asset register can be implemented. This is becoming a standard tool for inventory checking and planning of maintenance work, but its usefulness crucially relies on appropriate input information. The quality and topicality of data regarding the location and technical condition of assets directly affects a company's ability to reduce facility downtime and overall maintenance costs. The choice between using a drone, helicopter or plane to gather such data depends on the company's needs, the asset's location and current regulations.

Legal compliance & documentation

Power plants and transmission lines are considered critical national infrastructure, which often brings different requirements for performing flights over them as well as for storing and managing data. National legal regulations designed to ensure the safety of critical infrastructure require that power & utilities companies follow very strict rules on creating and updating documentation of assets' technical condition, as well as the timing of regular maintenance inspections. Moreover, data on energy infrastructure have to be stored on secure servers in companies' headquarters, or with certified external companies guaranteeing the proper level of security, and managed by specially trained employees. Dedicated solutions designed for power & utilities companies to acquire or manage data about physical infrastructure have to comply with industry security standards and national legal regulations.

Safety issue

Today, asset inspections require that a company's employees or subcontractors work at height and in dangerous environments. This is the main cause of many injuries and lethal accidents happening every year during assets inspections, exposing power & utilities companies to paying out large compensation. Furthermore, some asset inspections require at least a partial shutdown of the facility, with extremely high opportunity costs.

The application of aerial technologies to capturing information on the technical condition of assets can immediately decrease the number of accidents and minimise network downtime. Recording and storing images and video data from inspections also gives an additional tool to control the quality of inspection work and the level of employees' and subcontractors' engagement.

Source: PwC Drone Powered Solutions

[5] Source: WorldBank, CIA World Fact Book, PwC Analysis

Drones as repair tools for power transmission lines and critical infrastructure

Gathering data is not the only drone application being developed for the power & utilities industry. Drones can also be used to perform dangerous tasks at great heights, such as construction work, repairs or trimming vegetation growing around power lines. Drones' increasing capabilities already allow them to transport building materials as well as assemble, weld and attach different types of parts. One of the most interesting examples of drones' potential to perform dangerous tasks at heights was a test flight in Xiangyang in China's Hubei province, conducted by technicians from an electric power maintenance company. They used a flame-throwing drone to dispose of garbage that had settled on power lines. A similar solution can be applied to trimming vegetation growing around power lines. Drones can perform these tasks faster than humans, while reducing the risk of accidental injury or death. The ongoing development of technology, decreasing prices of drones and changes in legislation are encouraging more and more industry players to benefit from the devices' versatility.

Predictive maintenance supported by machine learning algorithms

However, the potential of drone applications in the power & utilities sector is not solely limited to these solutions. P&U companies can use a wide range of new technologies to solve the most pressing issues and enhance their operations. One of the most interesting technology applications involves implementation of machine learning in the asset inventory & maintenance processes. Machine learning is the science of using algorithms to learn how to solve complex tasks without being explicitly programmed. Algorithms are trained to solve tasks independently based on the analysis of provided examples of similar solutions. There are several different classes of machine learning algorithms, with one called deep learning being especially promising. The creation of deep learning algorithms was inspired by our understanding of how the neural networks located inside the human brain operate. PwC has been performing image data recognition, such as identifying deviations from infrastructure plans on construction sites, using machines trained by deep learning techniques, and achieving better results than with human employees.

Another example of successful research in this area involves a system to detect cracks in the steel components of nuclear power plants, created by a team of scientists from Purdue University in the United States under the supervision of Assistant Professor Mohammad R. Jahanshahi. The system automatically identifies cracks based on the changing texture surrounding them on the steel surface and informs technicians about the potential danger. Processing takes about a minute; it not only saves time for technicians and allocates their work more efficiently, but also reduces the risk of undetected damage.

By applying machine learning, energy operators can identify quality defects, malfunctions or inventory shortages faster and at a lower cost. Identification can be done automatically, without human assistance, from photos or a real-time video stream delivered by drones. Technology already allows drones to autonomously conduct inspections of power plants and transmission lines and to deliver real-time analytics regarding infrastructure condition.

2.3 Vegetation management

Tree branches or other vegetation making contact with power lines are the main cause of power outages. In most countries, vegetation management, defined as monitoring the forestry conditions and trimming trees, is the single biggest maintenance cost for power & utilities companies. By applying innovative technologies and redesigning vegetation management processes, industry leaders can improve the efficiency of trimming and repair services, as well as preventing future losses caused by falling trees and growing plants.

Technologies to collect data

The choice of technology to acquire data about vegetation should be based on predefined company needs. Depending on the desired outcome, we can choose between using traditional photogrammetry methods such as RGB cameras or applying LIDAR (Light Detection And Ranging), a detection system that works on the same principle as radar but uses light from a laser. The first method allows the real state of assets and the vegetation around them to be captured in 3D, but it requires good weather conditions such as no rain, no strong wind, and proper sunlight to acquire measurable data. While LIDAR can capture data with higher accuracy than RGB cameras and in any weather conditions, currently it is still the more expensive solution. Moreover, companies can use public and field sources of data (from manned inspections) to supplement data gathered using these technologies.

Besides choosing data acquisition technologies, it is equally important to decide which type of aerial vehicle should be used to carry cameras and LIDAR: drones, helicopters or planes. Each has its own advantages, with drones allowing the best data accuracy, helicopters being the most cost-effective and planes the fastest. Recent developments in drones,

Source: PwC Drone Powered Solutions

however, are now enabling them to compete with other types of aerial vehicles in both effectiveness and speed. Fixed-wing drones may offer an alternative to planes, while multi-rotor drones may replace helicopters. The unique advantages of UAVs include their ability to fly lower than other aerial vehicles, which results in higher data quality, and the lack of a human pilot on board, which reduces the risk of lethal accidents. The final choice of vehicle and on-board equipment should be made based on company expectations regarding data quality, acquisition time and costs.

Processing, analysing and managing data

To receive valuable information about where a field team should be sent to cut down vegetation, companies need more than just captured raw data: The information they gather has to be processed and analysed in order to determine which trees have to be trimmed immediately, and which can wait. By combining data gathered by aerial vehicles with information from public and field sources, as well as knowledge of the growth rates of particular types of plants, companies can create a complex model that informs them where field teams should be sent not only at the present time but also in the future. This approach reduces vegetation monitoring costs, improves risk identification and allows more effective resource allocation.

2.4 Drone technology enhancing water quality monitoring

Water quality monitoring is an important but challenging task, due to the time-consuming and labour-intensive methods of collecting and analysing water samples. Today, satellite images are being used to estimate some parameters (e.g. turbidity or cloudiness, chlorophyll content), making it more practical to analyse larger areas. However, the lower spatial resolution of these images often limits their applicability for monitoring smaller water sources (like streams), where conservation efforts are actually focused. Moreover, there are a number of additional challenges to remotely monitoring water quality by satellite: small streams are hard to see, there is limited control over when the satellite collects data, and most importantly, turbidity tends to be highest shortly after rain, when it is often too cloudy to see streams from satellites.

By applying UAVs with infrared cameras, scientists, employees of water services companies and government officials have the ability to monitor water areas remotely at a higher spatial resolution than ever before, at low cost and at any time. Drones might also be used for mapping and inspecting water supply infrastructure consisting of numerous as well as extensive: pipelines, sewage and drainage channels. One of the most interesting examples of drone use for water quality monitoring was a project conducted by the Department of Primary Industries, an Australian government state agency whose responsibilities include preservation of water resources. In December 2015 it deployed a program based on drone technologies and image data analytics to monitor the quality of water released into the lower Darling River. Over the next 6 months, drones successfully controlled the quality of 35,000 mega litres of water released from the Menindee Lakes into the river. Another useful application of drones for monitoring water facilities has been found by researchers from Nottingham Trent University. Two years ago, the scientists found that a high-resolution infrared camera could detect from a height the change in soil temperature that occurs when leaking water soaking into underground. This can be used to help reduce the vast quantities of water that may be lost from large-scale underground pipe systems, especially in desert countries where water is transported over large distances.

Tremendous rise in the volume of data will force companies to search for new ways to manage and store information

Massimo Pellegrino – Partner S&, PwC Italy Digital & Innovation Leader

Progressive digitalization of operational processes requires organizations to introduce new methods of gathering and analyzing accurate, precise and up-to-date information. Real-time awareness regarding technical conditions of their assets, such as power & utilities infrastructure is crucial to avoid power outages. Information about progress of construction works is necessary to prevent from project delays or non-compliance with project designs. Traditional methods of collecting this information rely on inefficient human work and often deliver intangible, hard to compare results. That's why applying drone technologies to capture various types of data regarding power plants, electrical substations or power lines a change driver change driver for the whole power & utilities industry. Drones can not only gather comparable and tangible data in a more efficient way than people located on the ground, but also, unlike manned aerial vehicles, they can do it without risking human life. By adding to these advantages the ability to obtain data of better quality than from helicopters or planes, due to drones' lower level of flight, it is clear why drones become a primary sources of information for designing, constructing, operating and maintaining infrastructure.

Another key issue related to the digitalization trend is the necessity of analyzing, distributing and managing vast amounts of digital data captured by drones or other types of data acquisition tools. Knowledge how to analyze data to receive useful insights is equally important as specialized tools to capture, process, integrate and visualize data. To streamline data analysis processes and take advantage of captured data, organizations need a unified digital platform where employees from different departments will be able to collaborate together. Digital platform can enhance the work of employees, as well as attract outside talents possessing technical capabilities to perform data processing and analytics tasks, which will all together work for the joint benefit of the organization.

3. Digital Platform

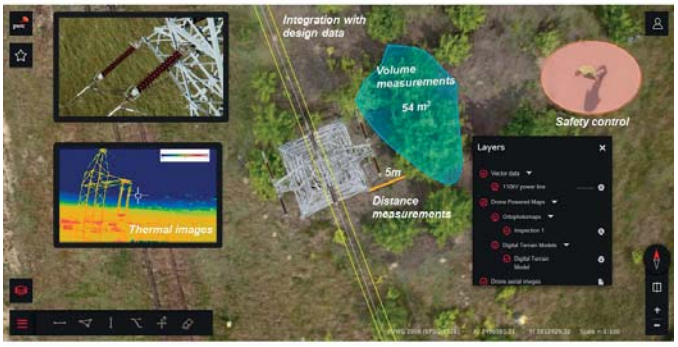
The use of drones to capture the current state of objects using various types of sensors generates enormous amounts of data, very often in different formats. Integration, analysis and management of such data in a way that ensures the right employees will have access to relevant information becomes a significant challenge for any type of organisation. Employees need specialised tools and technical capabilities to deliver useful insights corresponding precisely to their tasks. Any organisation that wants to use drone technologies and image data analytics should consider what solutions need to be implemented in order to allow employees to benefit from the gathered information gathered and further data analysis.

The PwC Drone Powered Solutions team has developed its own proprietary delivery software, the PwC Geospatial. App, enabling the integration, presentation and management of comprehensive data sets. It is a cloud-based platform that integrates geospatial data with products from various sources, and presents them in a clear and convenient way. Geospatial. App has a wide spectrum of functionalities such as displaying multiple layers (orthophotomaps, NMT, vector layers, etc.) or embedding additional files (photos, thermal images, reports) which can be attached to particular objects or to entire layers. Moreover, the software can track changes over time and allows for convenient measurement of distances between selected points, the height of objects, relative height, surface areas and coordinate capture.

All these functionalities offer PwC clients an easy and instant decision-making process based on high-quality, up-to-date information gathered by drones, planes, helicopters or satellites.

Software security is assured by compliance with strict digital security standards, in compliance with PwC IT Security policy. PwC's IT organization has a dedicated Information Security group that includes certified specialists in threat and vulnerability management, application security and risk management. Geospatial. App also undergoes penetration tests with every new release, performed by an external cybersecurity company.

The PwC Geospatial. App is a globally unique tool for independent review of data in a dedicated online panel available via any browser, based on the HTML5 standard. The external cloud platform provides convenient access to data via computers, mobile devices and from any location, without additional applications and with ultrafast transfer (up to 3 GB/s). Data integration, analyses and all other computing processes are conducted on dedicated servers, so they don't slow down the user's device. Upon request, a dedicated version of Geospatial. App data can be located according to the client's request, e.g. within the client's IT infrastructure. Geospatial. App can be integrated with the Client's ERP, maintenance, asset management, investment management and other systems. Default functionalities, configuration and analytics are easily adjustable to the client's particular needs and industry specifics.



Source: PwC Drone Powered Solutions

4. What are the opportunities for and challenges to drone powered solutions?

4.1 Key opportunities

Regulations

Drone technology is one of the innovations that will have the greatest impact on the world in the coming decades. The advantages are visible in the power & utilities sector, but also in many others. However, legal regulations sometimes constrain advances. Some countries have already started to develop a comprehensive regulatory framework to enable drone flights and deal with insurance of UAV pilots and aircraft, thus preventing certain problems in the implementation of solutions using drones. Changes in drone regulations, especially permission to perform BVLOS flights, will open up new opportunities for the Power & Utilities sector and others, and allow drones to perform increasing numbers of operations.

Technology development

Further advances in technology will bring new solutions, reduce costs and increase the potential of UAVs. Drone producers are constantly innovating and improving performance and adding new functionalities. Battery life will be one of the major issues, as improvements in this area will allow for longer flights, processes to be accelerated while cutting costs even further. Although camera resolution and sensor parameters are already impressive, further developments will allow data to be gathered with a higher level of precision, opening up new opportunities and allowing for analysis of details that were not previously recognisable.

Automation

The discussion about autonomous drones began a long time ago, and the technology is already available. Nevertheless, autonomous UAVs still have not become commonplace. Further development of autonomous vehicles may revolutionise the sector even further. Automation will bring greater precision, better adjustment of flight parameters, reduced exposure to human error and decreased costs. It will also open up a new array of opportunities for the drone sector, and enable the development of an increasing number of innovative solutions and possible use cases in other sectors.

4.2 Key challenges

Operational safety

The use of drones brings not only benefits but also concerns about operational safety. The rising use of drone technology increases the number of aviation accidents and ground collisions. Human error, loss of signal between drone and pilot as well as technical errors can lead to incidents that pose a real danger to public safety. For power & utilities companies, a drone crashing into power lines could cause blackouts and serious damage to energy infrastructure. The risk associated with drone operations demands that safety systems be applied to ensure detection of risks and prevention of accidents.

Data security

As drones capture detailed data about power & utilities infrastructure, there is a growing risk that confidential information could be hacked. This concern requires the implementation of data security systems to ensure effective protection. Data gathered by drones are usually transmitted to the cloud via Wi-Fi or Bluetooth, which increases exposure to cyber-attacks. As a result, drones are extremely vulnerable to cyber threats. Hackers may make use of unsecure connections to gain control of a drone's interface and obtain sensitive data. To tackle this problem, security systems that control the safety of data and connections need to be developed.

Machine learning and artificial intelligence tools can be taught not only to identify issues, exceptions or problematic patterns but it can also be vital by automating a response (e.g., creation of work orders) to address the critical business needs

Matt Labovich – Analytics Leader, US Industrial Products and Services

Over the past few years many of our power & utilities clients have started the journey to drive a digital transformation across their organization. Whether their investment is in enhanced drone capability, the utilization of IoT sensors, or other innovative concepts one thing is very clear: creating and collection of the data isn't good enough, P&U companies need to turn this data into actionable events. While years ago creating dashboards and performing data mining exercises provided important insights to company management, today, many of our clients are not satisfied with just learning more about their business. They want to use the data to make decisions about how to operate and maintain their assets more effectively and efficiently. Collected information that does not drive a decision or action is not worth collecting.

To extract the value out of this information, applying advanced analytical techniques and machine learning to identify opportunities for operational improvement is just the start.

Machine learning and artificial intelligence tools can be taught not only to identify issues, exceptions or problematic patterns but it can also be by automating a response (e.g., creation of work orders) to address the critical business needs. Any learnings from the issue resolution can be reintroduced into the analytical models to help predict needs in the future.

Tying the data creation, collection, analytics and decision making into specific business outcomes is key to the long term success of these innovative solutions and will move these activities from the successful proof of concepts phase to full blown mission critical business activities over the next decade. Companies that take this holistic view will create differentiators by driving lower cost to maintenance, higher asset availability, better insight to make business decisions and creating a safer environment for employees and customers.

5. Drone powered solutions

Drone Powered Solutions (DPS) is a global centre of excellence located in Europe. The team helps clients from various industries to maximise the potential offered by drone technologies.

Established in Poland in early 2015, it is the world's first professional services consulting team dedicated to industrial and business applications of drone technology, and its location is no accident: Poland is one of the first countries worldwide to have adopted detailed laws regulating the industrial use of drones (as early as 2013).

Over time, DPS has worked with clients from various industries to test applications of drone technology in their operations. Drone technology is proving to be a powerful tool for many sectors of the economy. We believe that skilfully making use of the possibilities offered by this technology will greatly improve the quality of daily processes, combining high precision, simplicity and unmatched cost-effectiveness.

Thanks to PwC's rich experience in strategic and operational planning and implementation, DPS support will help companies not only select the appropriate hardware but also implement complete operational systems. The scope of our competences includes strategy, process transformation, IT customisation, visual data processing and analytics. These competencies enable DPS to deliver End-to-End services to clients. DPS has also developed its own proprietary delivery software, the PwC Geospatial. App, allowing for integration, presentation and management of comprehensive data sets. Thanks to its wide spectrum of functionalities, the tool enables easy, instant decision making.

The DPS team already has unique experience, proprietary solutions and methodologies, but we're not stopping there. We are constantly focused on developing new ideas and technology (e.g. machine learning) to efficiently support customers in the new drone reality.

Authors

Strategic direction and editorial oversight

Michał Mazur
Partner, Drone Powered Solutions

Adam Wiśniewski
Director, Drone Powered Solutions

Jeffery McMillan
Director of Communications, PwC CEE

Editorial contribution

Matt Labovich
Analytics Leader, US Industrial Products and Services

Steve Jennings
UK Power and Utilities Leader

Massimo Pellegrino
Partner S&, PwC Italy Digital
& Innovation Leader

Norbert Schwieters
Global Energy, Utilities & Resources Leader

Editorial team

Jakub Jagiełło
Analysis & Project Coordinator

Anna Drabarek
Editorial Coordinator

Ewa Boguszewska

Aleksandra Chmura

Anna Jaworska

Filip Orliński

Rhys Kealley

To have a deeper conversation about this subject, please contact:

Michał Mazur
Partner, Drone Powered Solutions
michal.mazur@pl.pwc.com
Tel.: +48 502 184 684
PwC Poland

Adam Wiśniewski
Director, Drone Powered Solutions
adam.wisniewski@pl.pwc.com
Tel.: +48 501 049 409
PwC Poland

Steve Jennings
UK Power and Utilities Leader
steve.jennings@uk.pwc.com
Tel.: +44 (0)20 7212 1449

Norbert Schwieters
Global Energy,
Utilities & Resources Leader
norbert.schwieters@de.pwc.com
Tel.: +491754323786

Massimo Pellegrino
Partner S&, PwC Italy Digital
& Innovation Leader
massimo.pellegrino
@Strategyyand.it.pwc.com
Tel.: +39 345 2448062

Matt Labovich
Analytics Leader, US Industrial
Products and Services
matthew.labovich@pwc.com
Tel.: +1 703 725 8255

Pascale Jean
Partner, France & EMEA Power
& Utilities Leader
pascale.jean@fr.pwc.com
Tel.: +33 6 74 44 79 11

Comments or request?
Please visit ***www.dronepoweredsolutions.com*** *or send us an e-mail.*