



TRANSFORMING ENERGY OPERATIONS WITH AUTONOMOUS AVIATION NETWORKS

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ABSTRACT

Operational readiness is critical for the energy sector, where efficiency, safety, and regulatory compliance are paramount. With the advent of Remotely Piloted Aircraft System (RPAS) technology, energy companies across North America are transforming their operations by creating a digital twin of generation and distribution infrastructure. RPAS offer a high-performance, scalable solution for various applications, from infrastructure inspection to environmental monitoring and disaster response. This whitepaper explores the current state of drone operations in the North American energy sector, the benefits of scaling these operations, and the key technologies driving this transformation.

WHEN IS THE RIGHT TIME FOR AUTONOMY?

- What are the cost savings, process improvements and ROI expectations from autonomous RPAS over manned alternatives?
- How do autonomous RPAS operations ensure safety and reliability with minimal risk to personnel and infrastructure during flight ?
- How do autonomous RPAS operations align with and ensure compliance to aviation and environmental regulations?
- How does data collection from autonomous RPAS operations enable digital twins of energy infrastructure for AI-augmented operations?

MARKET DRIVERS



OPERATIONAL READINESS

The energy sector's reliance on vast and complex infrastructure, often spread across remote and hazardous locations, makes operational readiness a challenging yet critical objective. Companies must ensure the safety and efficiency of their operations while complying with stringent environmental regulations. Traditional methods of inspection and maintenance, which often involve manual labor and costly equipment, are increasingly being supplemented or replaced by drones. This shift is driven by the need for real-time data, improved safety, and cost savings.

Key areas where drones are making an impact include:

Inspection and Maintenance:

Drones equipped with high-resolution cameras and sensors are being used to inspect pipelines, power lines, wind turbines, and solar panels. These drones provide real-time data and reduce the need for manual inspections, which are often risky and time-consuming.

Environmental Monitoring:

Energy companies are deploying drones to monitor environmental conditions around their operations, detecting gas leaks, emissions, and other environmental hazards. This capability is essential for compliance with regulatory requirements and for minimizing the environmental impact of energy production.

Disaster Response:

In the event of natural disasters or industrial accidents, drones can quickly assess damage and provide critical information for response efforts. This rapid assessment capability is vital for minimizing downtime and ensuring the safety of personnel.

FACTORS AFFECTING SCALE

REGULATORY COMPLIANCE

Navigating the complex regulatory landscape in North America is a significant challenge for energy companies looking to scale drone operations. Ensuring compliance with Federal Aviation Administration (FAA) regulations in the U.S. and Transport Canada rules is essential for safe and legal drone operations. Companies must also stay informed of evolving regulations around Beyond Visual Line of Sight (BVLOS) operations, which are crucial for scaling drone activities.



DATA MANAGEMENT AND ANALYSIS

As drone operations scale, so too does the volume of data generated. Energy companies must invest in robust data management systems that can handle large volumes of information and provide actionable insights. Integration with cloud-based platforms and the use of AI and machine learning for data analysis will be critical for managing and leveraging this data effectively.



AUTONOMOUS OPERATIONS

The move toward autonomous drone operations will be a key factor in scaling. Autonomous drones can operate with minimal human intervention, allowing for continuous monitoring and inspection of energy infrastructure. This capability will enable companies to deploy drones across vast areas and in challenging environments without the need for on-site personnel.

PARTNERSHIPS

Energy companies should consider partnerships with specialized drone service providers to scale operations efficiently. These providers can offer expertise in drone technology, regulatory compliance, and data management, allowing energy companies to focus on their core operations.

DATA SECURITY

Protecting the sensitive data generated by drones is critical. Energy companies must implement robust cybersecurity measures to prevent unauthorized access and data breaches.

SYSTEMS INTEGRATION

Effective scaling requires seamless integration of drone operations with existing energy infrastructure and systems. This includes integrating drone data with Geographic Information Systems (GIS), Supervisory Control and Data Acquisition (SCADA) systems, and other enterprise platforms. Standardized protocols and communication networks will be essential for ensuring smooth operations and data flow.



EMERGING TECHNOLOGIES

ADVANCED PLATFORMS, SENSORS AND IMAGING

High-resolution cameras, thermal imaging, LiDAR, and other advanced sensors enable drones to capture detailed data in real-time, improving the accuracy and effectiveness of inspections and monitoring.



AI AND MACHINE LEARNING

These technologies are being integrated into drone operations to enhance data analysis and predictive maintenance. By identifying patterns and anomalies in the data, AI-powered drones can predict equipment failures and optimize maintenance schedules, reducing downtime and operational costs.

CELLULAR CONNECTIVITY

The rollout of 5G networks across North America will significantly enhance drone operations by providing faster and more reliable communication links. This will enable real-time data transmission and support the deployment of autonomous drones over larger areas.

OPPORTUNITY READINESS

The opportunities presented by drone technology far outweigh the challenges. By enhancing operational readiness, improving safety, and reducing costs, drones offer a transformative solution for the energy sector. Companies that invest in scaling their drone operations now will be well-positioned to lead the industry in the coming years.

DRONE DOCKING STATIONS

Complementary deployment of drone docking stations presents a transformative opportunity for transmission line infrastructure inspection and maintenance. Traditionally, inspections have required manned inspections or aerial surveys, which can be both time-consuming and costly.

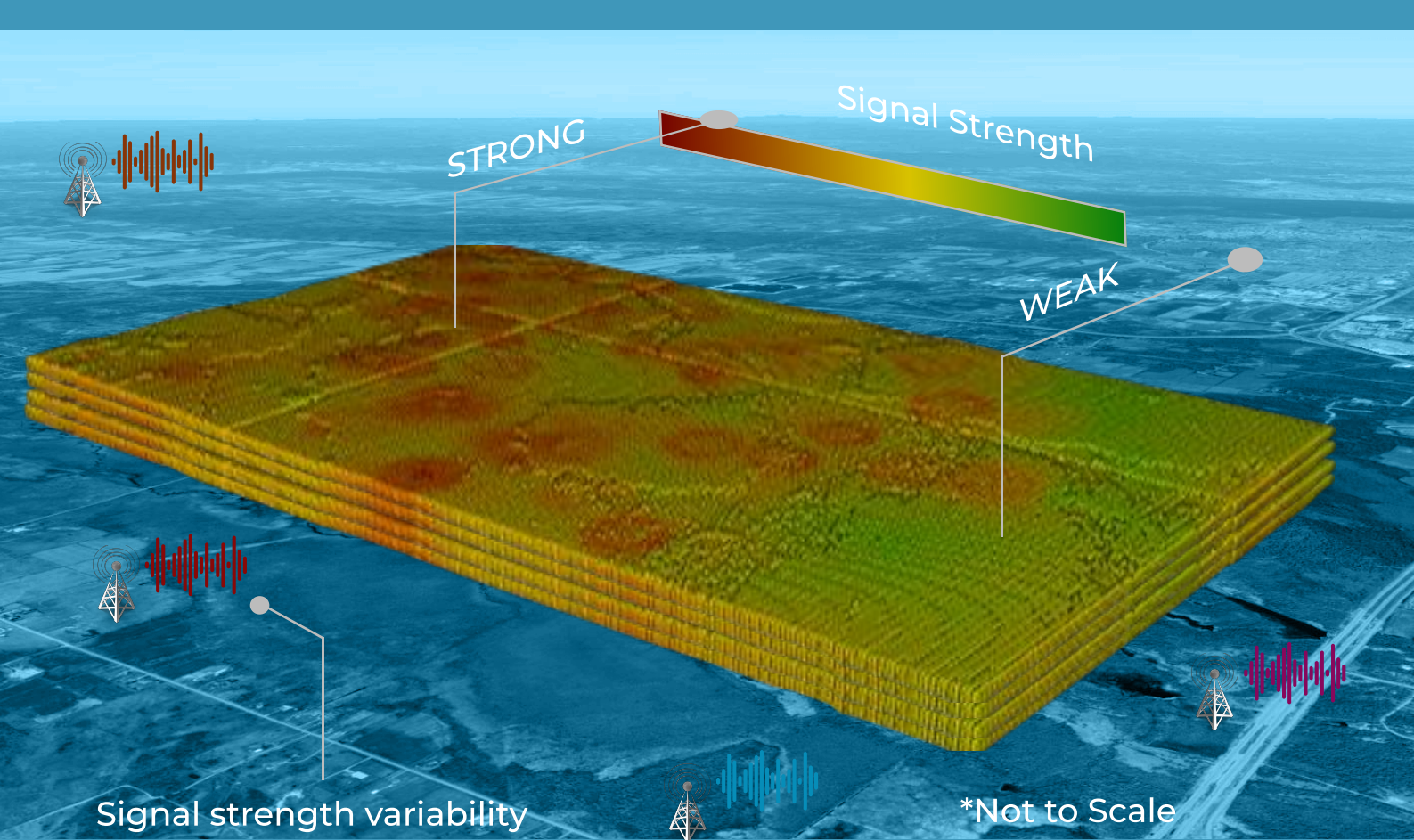
RPAS docking stations, strategically placed along transmission lines, enable drones to autonomously inspect long stretches of transmission lines, collecting high-resolution data on potential issues like corrosion, structural damage, or vegetation encroachment. These drones can land, recharge, and redeploy from these stations, allowing for continuous, uninterrupted monitoring of critical infrastructure without the need for human intervention, increasing both efficiency and safety in the process.

Autonomous RPAS can be deployed on-demand, at regular intervals, or in response to adverse weather events, ensuring that problems are detected early before they lead to outages or expensive repairs. For energy companies managing extensive grids in remote areas, the ability to continuously monitor transmission lines autonomously can enhance service reliability, reduce downtime, and improve overall asset management, making it an attractive investment for the future of smart grid infrastructure.



SAFE PATH AVIATION NETWORK

ClearSky Connect is an innovative technology company that leverages artificial intelligence (AI) to predict connectivity service levels from existing cellular network operations data at altitude. Our flagship product, the SafePath Aviation Network, (SPAN) is designed to support enterprises scaling up their drone operations by providing accurate predictions for command and control links as well as payload (sensor or FPV) connectivity across various geographic regions. By ensuring regulatory compliance for connectivity risk assessment and offering robust data networking capabilities, ClearSky Connect aims to become the leading aviation network provider for the enterprise RPAS market.



SPAN SERVICE PORTFOLIO

SAFE PATH RISK ASSESSMENT

SPAN is able to perform predictive connectivity risk assessment for both C2 and payload connectivity as part of flight planning and approval processes. Connectivity performance is derived from Mobile Network Operator (MNO) radio operations data and calibrated using empirical data collected from ongoing AAV flights. Risk can be predicted at any point in the enterprise operations airspace and at any future time of day and week.

GROUND RISK ASSESSMENT

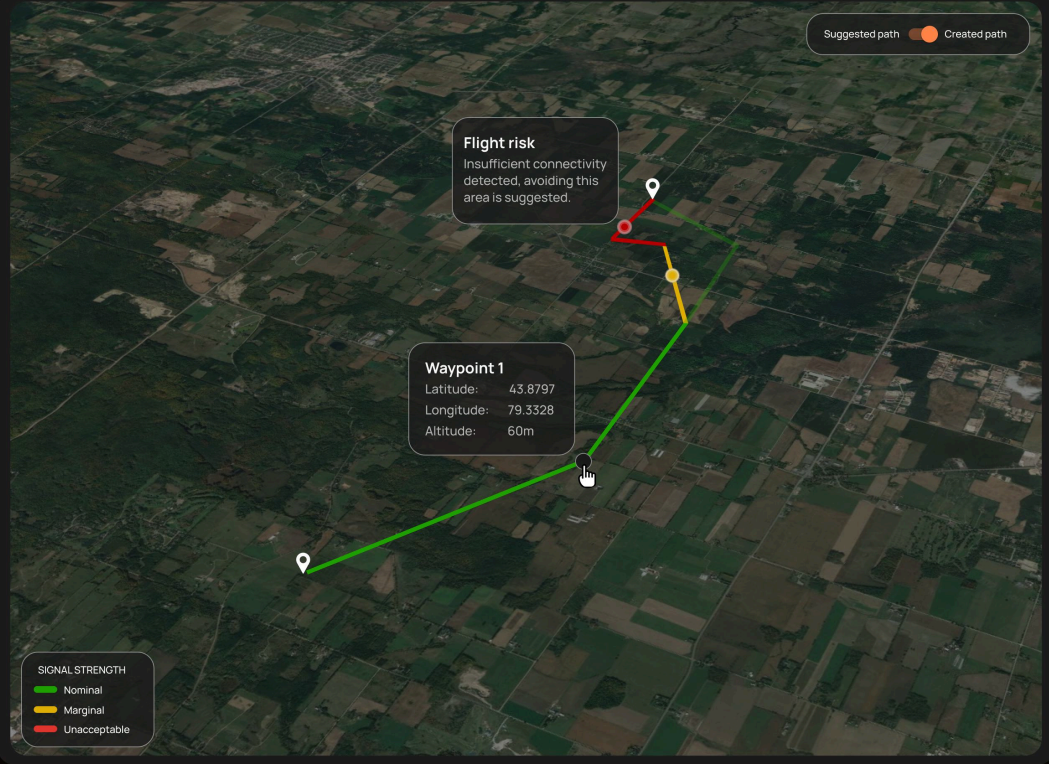
ClearSky is currently developing ground risk assessment using device data. The ability to determine subscriber or device density for a given area can be represented as a ground risk heat map. Currently population density is estimated from census data that may be many years old. SPAN Ground Risk Assessment will provide both predictive and time of flight assessment of ground risk from flyover of populated areas.

DATA POOLING

SPAN will provide pooling of data network consumption across multiple AAVs, reducing complexity associated with matching connectivity with platform and application. All AAVs will be matched to the same SPAN network and connectivity profiles for C2 and payload.

RPAS LINK MONITORING

Every SPAN network established for an enterprise operational area is calibrated using empirical data collected from RPAS during flight. ClearSky is extending this capability to include connectivity situational awareness. Real-time data collected by the RPAS will be continuously compared to predicted data for the flight path. If any deviation from predicted performance (including safety buffer), the pilot will be alerted. This may occur during maneuvers, as a result of terrain shadowing or RF hand-over.



Connectivity risk profile

#346912
1234 Flight 03

Flight operator: John Smith
RPAS name: DJI Mavic 3 Pro
Location: Toronto
Flight Date: Sep 10, 2023, 12:30PM

CREATED FLIGHT PATH (by Operator)
Submitted: YES (See waypoints)
Waypoints: 6 (See details)
Payload: Lidar
Risks found: 2 (See details)

SUGGESTED FLIGHT PATH (by Clearsky)
Submitted: YES (See waypoints)
Waypoints: 5 (See details)
Payload: Lidar
Risks found: 0

SELECT FLIGHT PATH FOR APPROVAL

Clearsky suggested flight path

Decline Flight Path Approve Flight Path

SAFE PATH CONSOLE

The ClearSky SafePath Aviation Console is designed to improve operational readiness in large-scale drone operations for public safety. Operators simply input flight path waypoints and hundreds of complex radio and connectivity performance metrics are processed through algorithms based on cellular networks, RPAS platform and application into a simple connectivity risk heat map for each flight plan with AI-based options that can be used for regulatory approval.

ENTERPRISE SPAN BENEFITS

- Enhanced Data Security
- Regulatory Compliance
- Improves connectivity across infrastructure.
- Risk Management
- Robust security measures and real-time monitoring
- Streamlines integration across operations
- Enhances predictive maintenance
- Reduces operational disruptions



ClearSky

- Dashboard 1
- Connectivity Profiles
- RPAS
- Payload
- Settings
- Logout

Johnatan Smith
Drone operator

Dashboard

! **Connectivity Mitigation Required**
Connectivity performance on one or more segments in the proposed flight path is unacceptable and mitigation alternatives must be provided.

NEW FLIGHTS INITIATED

15 new

▲ +12% vs last week

AVERAGE APPROVAL WAITING TIME

12m 24s

▲ -6% vs last week

CONNECTIVITY PROFILE STATS

58

CREATED

2

PENDING

3

CANCELLED

53

COMPLETED

Flight tracker FLIGHT # 346912 Manage

- +

Flight Connectivity Risk Profile Created

Connectivity profile created
Sep 21 2023 07:22 AM
- +

Connectivity Profile Submitted

Connectivity profile submitted
Sep 21 2023 07:30 AM
- +

Pending approval

Connectivity profile pending approval
Sep 21 2023 07:30 AM
- +

Flight clearance

This action is pending
- +

Flight executed

This action is pending

Connectivity Risk Profiles Created Sort by ▾

FLIGHT ID	OPERATOR	LOCATION	FLIGHT DATE	STATUS	ACTION
#346912	Johnatan Smith	Toronto, ON	Aug 14, 2023	Approved	See details
#346911	Johnatan Smith	Ottawa, ON	Aug 02, 2023	In Progress	See details
#346910	Johnatan Smith	Ottawa, ON	Jul 24, 2023	Completed	See details
#346909	Johnatan Smith	Toronto, ON	June 08, 2023	Completed	See details
#346908	Johnatan Smith	Ottawa, ON	Apr 02, 2023	Completed	See details
#346907	Johnatan Smith	Ottawa, ON	Apr 02, 2023	Cancelled	See details
#346906	Johnatan Smith	Toronto, ON	Feb 16, 2023	Completed	See details

GEORGIA POWER ROI

The drone team discovered 5174 abnormal conditions on lines and structures as compared with 1150 abnormal conditions found by the traditional inspection team from the ground only. Of those, 35 conditions were considered critical and needed to be addressed as soon as possible. The team from the ground found 17 critical conditions by comparison.

For the problem areas identified, the drones took about 48,000 images for diagnosis and analysis. GPC found it could realize cost savings of about 60% on a yearly basis with drone inspections while producing improved image data sets, locating more critical problems on lines, generating clear documentation of repairs.

- T&D World (Aug 19, 2024)

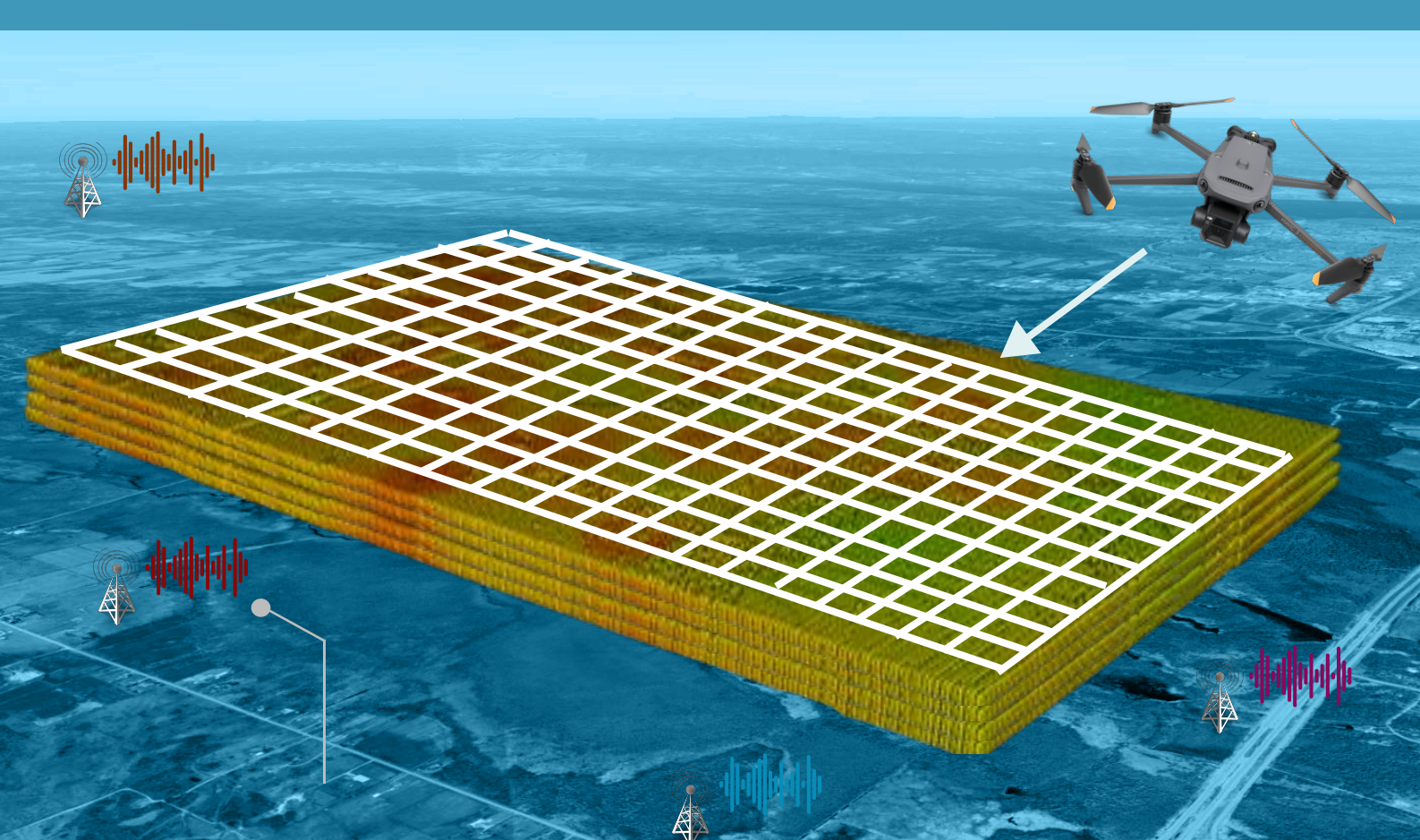


SAFE PATH vs PRIVATE RADIO

ClearSky is very cost effective when compared to a **private radio installation**. In order to meet risk assessment criteria for regulatory approval, a private radio network would require connectivity performance data be aggregated using manual survey methods. An RPAS would have to be flown several flights at several vectors and altitudes over several days, requiring significant resource investment **even after capital investment** for RF technology.

ClearSky calculates this manual survey method costs over **5X the annual cost of a SPAN**, and would have to be refreshed periodically, increasing costs further.

ClearSky SPAN provides immediate results and ROI that is extensible and real-time enabling energy enterprises to enjoy BVLOS economics and benefits immediately



TRANSFORMING ENERGY



SUMMARY

Drone technology is rapidly becoming a vital tool for energy companies in North America. By enhancing operational readiness, improving safety, and reducing costs, drones are transforming the way energy companies conduct inspections, monitor environmental conditions, and respond to disasters. However, to fully realize these order-of-magnitude benefits, companies must focus on scaling their drone operations effectively. This will require overcoming regulatory challenges, investing in data management and analysis, and integrating drones with existing systems.

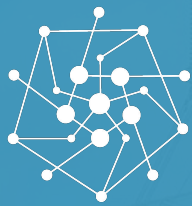
By doing so, energy companies can unlock the full potential of drone technology and position themselves at the forefront of the industry.

ABOUT CLEARSKY CONNECT

ClearSky Connect www.clearskyconnect.com is a communications services provider for the Remote Piloted Aircraft Systems (RPAS) market in Canada. Based in Ottawa, ClearSky is developing an advanced portfolio of software, data and communications services that will assist public and private enterprise with pre-flight, in-flight and post-flight connectivity assessment, management and mitigation.

References

- Federal Aviation Administration (FAA) Drone Regulations.
- Transport Canada Drone Rules and Guidelines.
- Industry reports on drone adoption in the energy sector.
- Case studies on drone operations in North American energy companies.



ClearSky
Connect