



Karlene Fine
North Dakota Industrial Commission
State Capital – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840

Dear Karlene,

If awarded funds per the attached proposal, Evolve Analytics LLC commits to performing the specified tasks and in doing so deliver specified outcomes.

Evolve Analytics LLC is in good standing with the State of North Dakota (Attachment B) and has no outstanding debts or obligations.

Included is the \$100 application fee along with two hard copies per submission instructions.

Let me know if you need anything further.

Thanks for your time and assistance.

Respectfully,

Joshua M. Riedy

Dr. Joshua M. Riedy

Founder and CEO



Renewable Energy Program

North Dakota Industrial Commission

Application

Project Title: Autonomous Operations within the North Dakota Renewable Energy Sector

Applicant: Evolve Analytics, LLC

Principal Investigator: Dr. Joshua M. Riedy

Date of Application: 12/14/20

Amount of Request: \$500,000

Total Amount of Proposed Project: \$2,271,645

Duration of Project: 24 Months

Point of Contact (POC): Dr. Joshua M. Riedy

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POC Email: josh@e-analytics.net

POC Address: Evolve Analytics, LLC - 4200 James Ray Drive - Grand Forks, ND 58202

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- **Xcel Energy**
- **Minnkota Power**
- **Microsoft**
- **UND-RIAS**
- **Northern Plains UAS Test Site**

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ABSTRACT

Objective – A Phase I proposal revolutionized renewable energy operations, enabling sophisticated drone use by minimally trained, onsite technicians with the push of a button. This was validated by paid engagements on North Dakota wind sites, specifically those owned by Xcel Energy, NextEra (Otter Tail Power), Enel Green Power, and Acciona. (See Demonstration Video: <https://vimeo.com/user118060877>) Building upon that foundational work, this Phase II proposal seeks to build a full suite of artificial intelligence (AI) powered software applications. Joined by industry partners, (Xcel Energy and Minnkota Power), technical partner (Microsoft), and collaborators (University of North Dakota Research Institute for Autonomous Systems and Northern Plains UAS Test Site); Airtonomy is maximizing the value proposition of autonomous drones operated by onsite wind technicians offering significant time, convenience, scalability, and accuracy advantages over existing processes. In doing so, North Dakota is furthering its position as a leader within the drone industry, while creating high impact computer science, engineering, and software development positions. With more than 60,000 turbines domestically, and more than 5 times that many internationally, the impact of this project, namely placing multiple drones on wind sites, each with the ability to perform several critical functions, can be measured in the millions.



Expected Results – Simply put, the result of this endeavor will be daily onsite use of drones by technicians for a wide variety of on-demand, push button applications powered by AI. (See Attachment I for illustration of Xcel use of Airtonomy) Enhanced use of simulation (Microsoft AirSim), monitoring, and artificial intelligence will enable Airtonomy to develop and refine wind site applications including: 1) blade condition assessment; 2) turbine component assessment; 3) severe blade damage detection; 4) blade icing detection; 5) avian mortality assessment; 6) substation inspection; and 7) power line inspection. Leveraging high-performance, affordable drones, specifically by incorporating them as a daily use operational solution, will reduce cost significantly, while aiding what is a paramount worker shortage, evidenced by the Wind Turbine Service Technician occupation having the #2 highest percent growth of employment between 2016-26. (<https://www.bls.gov/ooh/fastest-growing.htm>)

In addition to substantially lowered operating costs, outcomes will increase power generation through enhanced asset condition assessment and regulatory compliance. Enhanced renewable energy power generation has the potential to entice large technology companies, such as Microsoft, to build datacenters within the state. Beyond Renewable Energy, the proposal will create high value careers in areas such as software development, engineering, and computer science within the state. Since awarding of a Phase I Renewable Energy Grant, Evolve Analytics added 12 software development, engineering, and computer science positions were added with plans to more than double that number in 2021.

Duration: The proposal calls for a roughly 24-month project duration (March 2021 through February 2023).

Total Project Cost: A total estimated project cost is \$2,271,645.00, which includes dedicated staff time, contracted services, hardware, software, equipment, and operating costs such as travel. Airtonomy will also leverage up to \$380,000.00 of funding from other corporate partners which will be used to test onboard compute capability for the intended purposes.

Participants - Evolve Analytics (EA), a North Dakota limited liability corporation located in Grand Forks, and supported by the UND Aerospace Foundation, the North Dakota Department of Commerce, Microsoft TechSpark, the Grand Forks Region EDC, and the City of Grand Forks; has partnered with the University of North Dakota, specifically the Research Institute for Autonomous Systems (RIAS), the Northern Plains UAS Test Site, and corporate partners Xcel Energy, Minnkota Power, and Microsoft.

PROJECT DESCRIPTION

Objective - This proposal builds on the success of a Phase I proposal, which revolutionized the commercial use of autonomous drones enabled by artificial intelligence on North Dakota wind sites. This will be accomplished by deploying a comprehensive set of applications that offer significant time, convenience, scalability and accuracy advantages over existing processes. Operated by onsite technicians, such a tool will dramatically enhance asset inspection and maintenance capabilities within the Renewable Energy Sector, using drones to enhance critical operational aspects such as:

- Blade Icing Detection
 - Identification of periods when icing may impact operations through use of observing systems including icing detection sensors and Computer Vision/Machine Learning
 - Communication of potential icing impacts
- Avian Mortality Assessment
 - Improving safety by reducing the required walking distance of a biologist in potentially hazardous areas.
 - Obtaining more accurate results by allowing the drone to fly in the areas that may be temporarily inaccessible.
 - Lowering costs by reducing the man-hours necessary for these programs.
 - Application of AI to active video monitoring of bird traffic through wind sites can identify intervention opportunities facilitated by onsite drones.
 - The outcome will be significantly reduced mortality, especially for protected bird species.
- Blade Condition Assessment
 - Computer Vision/Machine Learning (CV/ML) based inspections are highly repeatable and highly accurate offering an unparalleled basis for time-based change detection.
 - Drone hardware resilience coupled with ready availability is a staff force multiplier.
 - Regular visual inspections combined with data collected from equipment control systems will provide an unparalleled foundation for predictive maintenance.
 - Predictive maintenance modeling should inform repair and replacement decisions.

- Expediting insurance claims and work orders with access to historical inspection information and timely visual information.
- The overall intended outcome is to lower repair costs, while simultaneously increasing power output.
- Severe Blade Damage Detection
 - Detection can automatically be triggered by events (storm, lightning strike), equipment control systems (gearbox friction, power cell degradation, reduced power curve), technicians, or command centers.
 - Readily obtaining timely, high-quality imagery and video as needed.
- Turbine Component Assessment
 - Current manual practices, such as climbing or rappelling, can be supplanted.
 - Enhanced timeliness of reconnaissance positively impacts the outcome, especially when automatically triggered by equipment control systems or following a natural disaster,
 - In the unfortunate event of an accident, drone-based surveillance can aid emergency response.
 - Using vigilant site monitoring to mitigate unsafe trespassing.
 - Rigorous testing of safety-oriented processes and safeguards will ensure safe system operations. Humans, including onsite staff and manual aviation, unconditionally receive “right of way” priority.
 - Routine site surveillance can be conducted remotely and be event driven.
 - Improving emergency response efforts via additional situational awareness.
- Substation Inspection
 - Inspect all relevant components with airframe resistant to electromagnetic interference and able to capture lidar, RGB, and thermal sensor data
- Power Line Inspection
 - Ability to autonomously navigate around and between poles to capture relevant lidar, RGB, and thermal sensor data
 - Avoid obstacles that may obscure flight path

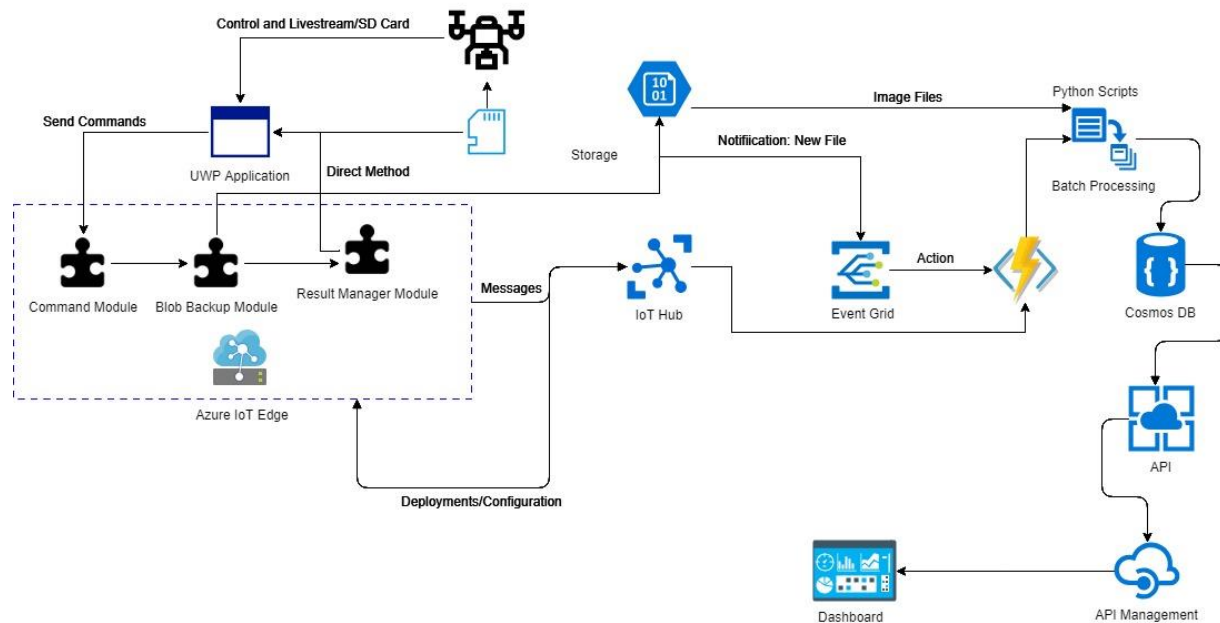
Methodology - Proposed development will be completed within 24 months of project initiation. The milestones for this project, which are aligned with its tasks, are:

- Blade Condition (March 2021)
- Severe Blade Damage (November 2021)
- Turbine Component (November 2021)
- **Complete Microsoft AirSim (January 2022)**
- Avian Mortality (March 2022)
- Blade Icing (March 2022)
- Substation (April 2022)
- Power Line (April 2022)
- FAA Waiver (BVLOS) (February 2023)

Software Solution

Airtonomy Solution - The Airtonomy solution consists of the following components: Robot Operating System application, Universal Windows Protocol application, Azure Internet of Things Framework, Azure, Artificial Intelligence/Machine Learning/Computer Vision, optimization algorithms, and an integrated backend control system intended to facilitate remote drone operation. Together these form an end-to-end autonomous operations solution, to which additional applications can be built and deployed.

The Evolve Analytics' Airtonomy solution will be expanded to include rules based and safety-oriented processes, and safeguards that will ensure safe remote system operations. Development will take place to coincide with enhancements to Microsoft's AirSim simulation environment, of which Airtonomy will be part of an Early Adopter Program. Testing will occur on three staffing levels using advanced simulation (Microsoft AirSim) followed by field tests to ensure rigor. All development activities will be coordinated through the Northern Plains UAS Test Site and University of North Dakota Research Institute for Autonomous Systems in order to ultimately obtain Federal Aviation Administration approval in the form of a permanent beyond visual line of sight (BVLOS) waiver.



It is expected that Xcel Energy will establish initial capability to deploy Airtonomy applications within an incident response framework and as an internal business asset. By working with government counterparts, it is expected that Xcel Energy will lead the industry in establishing Airtonomy as a viable commercial tool used within the Renewable Energy Sector, and EA, Xcel Energy, Minnkota Power, Microsoft, UND-RIAS, and NPUASTS will have built a pathway for continued growth of Airtonomy and related technologies to support the Renewable Energy industry through the expansion of technology and regulatory options.

Anticipated Results - Anticipated Results are as follows:

- **Develop, deploy, test, and commercialize 7 applications built using the Airtonomy platform, that combined will constitute a modern, robust, on-demand tool that technicians can operate with the push of a button.**
- Validate the Federal Aviation Administration safety case and associated simulation through physical testing at ND Renewable Energy sites.
- Successfully demonstrate to the Federal Aviation Administration safe deployment of Airtonomy capabilities to enhance on-demand, push button drone operations on Renewable Energy sites.
- Obtain a permanent Federal Aviation Administration waiver for Airtonomy in relationship to wind energy sites.
- **Seize a first of its kind opportunity by commercializing the Airtonomy solution, operated by on-site technicians (via a permanent FAA operational waiver), with the intention to grow market share within the Renewable Energy and Utility Sector in real-time as the Federal Aviation Administration (FAA) loosens regulations such as Beyond Visual Line of Sight (BVLOS), which are led by the Northern Plains UAS Test Site, thereby allowing drones to operate in civilian airspace.**

Facilities - This project will be hosted at North Dakota Renewable Energy sites. The site selection process is as follows:

- Federal Aviation Administration (FAA) input is crucial. Criteria will be predicated on factors including 1) domain appropriateness, especially as it relates to controlled airspace, remoteness, and autonomous deployment suitability; 2) site availability and convenience; 3) site simulation feasibility; 4) safety factor analysis.
- Once criteria are established, representatives from UND, NPUASTS, EA, Xcel Energy, Minnkota Power, and Microsoft will jointly select appropriate sites.
- Phase I work was conducted across 9 North Dakota wind energy sites.

Resources - As observed above, there will be three types of resources in this project:

- Hardware
- Software
- AI: Machine Learning/Computer Vision
- Human

Hardware includes:

1. Commercially available drones and accessories
2. Custom created mounting components for onboard processor and sensors
3. Monitoring instruments (including weather condition instruments)

Software includes:

1. Airtonomy platform with control software that includes rules based & safety-oriented processes, and safeguards
2. Microsoft Azure, including Azure IoT (Internet of Things), serves as the data storage, processing, visualization, and transportation platform
3. Microsoft AirSim (Aerial Informatics and Robotics Simulation), an open-source robotics simulation platform

AI includes:

1. Custom built machine learning and computer vision workflows enabled by the Airtonomy platform

Significant Human Resources will be provided by the participants and subcontractors to accomplish the tasks identified above.

The Project Team has substantial experience in performing and managing all these areas.

Techniques to Be Used, Their Availability and Capability - The combined, proven expertise of EA, UND-RIAS, the Northern Plains UAS Test Site, Xcel Energy, Minnkota Power, and Microsoft, is necessary to the creation of highly sophisticated, first of its kind, applications built using the Airtonomy platform. The main techniques applied are as follows:

- **Hardware Design:** Custom mounting solutions to house necessary sensors and onboard processor to the drone frame and other infrastructure.
- **Software Design:** Expansion of the Evolve Analytics' Airtonomy platform to include rules based and safety-oriented processes, and safeguards that will ensure safe autonomous operations. Development will take place to coincide with design of custom components as well as artificial intelligence work conducted by Evolve Analytics' computer scientists. Testing will occur on three staffing levels using advanced simulation (Microsoft AirSim) followed by field tests to ensure rigor. All development activities will be coordinated through the Northern Plains UAS Test Site and University of North Dakota Research Institute for Autonomous Systems in order to ultimately obtain Federal Aviation Administration approval in the form of a permanent waiver.
- **Artificial Intelligence (AI), Computer Vision (CV), Machine Learning (ML), and Robotics (RO):** Significant use of AI, CV, ML, and RO are essential to the enablement of applications built on the Airtonomy platform. Extensive algorithmic logic is necessary to facilitate the logic that removes human factors, thereby affording remote operation on Renewable Energy sites.
- **Complex Simulation:** The Microsoft AirSim platform solves these two problems: the need for large data sets for training and the ability to debug in a simulator. It provides a realistic simulation tool for designers and developers for seamless generation of the amount of training data they require. Also, AirSim leverages current game engine rendering, physics, and perception computation to create accurate,



real-world simulations. Together, this realism, based on efficiently generated ground-truth data, enables the study and execution of complex missions that are time-consuming or risky in the real world. For example, collisions in a simulator cost virtually nothing, yet provide actionable information for improving the design of the system.

Environmental and Economic Impacts while Project is Underway - There are no adverse environmental and economic impacts of this project. The project should achieve the Ultimate Technological and Economic Impacts described below.

Ultimate Technological and Economic Impacts – With more than 60,000 turbines domestically, and more than 5 times that many internationally, the impact of this project, namely placing multiple drones on wind sites, each with the ability to perform several critical functions, can be measured in the millions.

Push button use of Airtonomy by on-site technicians creates an entirely new dynamic within the Renewable Energy Sector. Significant increases to operational efficiencies will be profound, as Airtonomy provides an immediate, safe, and cost-effective first-response layer that is autonomous, prompted by control systems as well as the emergency response center, and integrated directly with the enterprise resource management system. This capability delivers unparalleled situational awareness, enabling entities like Xcel Energy and Minnkota Power to benefit from actionable intelligence in the form of timely decisions, reduced outages, and most importantly significantly enhance safety.

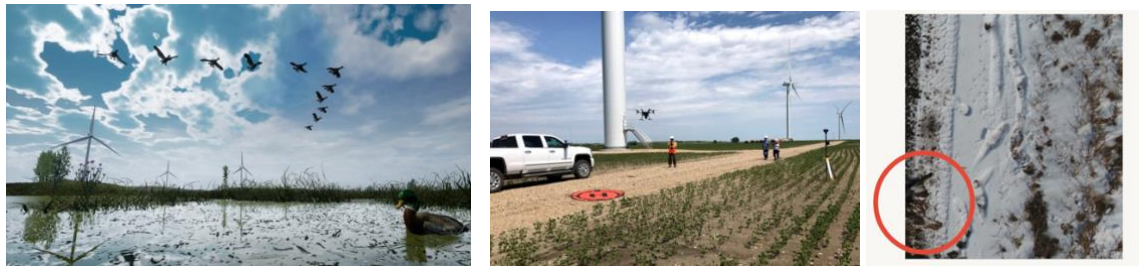
Anticipated economic impact of having readily available (365 day x 24 hours) commercial deployment of a secure, autonomous, multi-drone, operations performed by onsite technicians is multi-faceted. Considering multiple drones can continually conduct operations at any given time the need for onsite staff is significantly lessened, if not eliminated. This can provide instant operational efficiencies measured in hundreds of thousands of dollars. Staff can now focus on “hands on” tasks related to maintenance. Using a conservative wind energy scenario, at a price of \$23/MWH, assuming a monthly daytime output of \$12,000/turbine, a 3% increase in output by virtue of enhanced blade maintenance equates to roughly \$360 per turbine per month. At a 100-turbine wind site, this equates to roughly \$432,000 in increased revenue generation.

Environmental survey costs are significant. Typical post-construction mortality monitoring for birds and bats in general is about \$200,000 per year at wind sites. Similar mortality monitoring for eagles (large birds) is about \$150,000 per year at wind sites. The cost to do a raptor nest survey is about \$75,000 per year at wind sites. The cost to do the special habitat surveys (native prairie surveys) is about \$25,000 per wind site and only one is done prior to construction. Wetland Surveys are completed pre-construction and vary widely depending on how many wetlands are in the area. \$50,000 is a rough for one-time wetland surveys. The opportunity to significantly reduce, if not eliminate such costs using the Airtonomy Avian Mortality solution, is tangible.

The proposed applications also generate new employment opportunities in fast-growing and highly desirable careers such as data science, software development, engineering, and UAS in North Dakota; helping the region to retain and attract top talent professionals in competitive areas. As a first mover in the space, by virtue of a permanent FAA operational waiver, the market for push-button applications

operated by on-site technicians is exploding. For each sale, services such as simulation and route optimization are necessary. So too is the Airtonomy software platform. Collectively the economic impact of this project is profound considering the fast-growing Renewable Energy Sector. Expansion within the energy industry to areas such as power distribution and pipeline inspection are targeted areas of growth as most are located in remote areas not unlike renewable energy.

Why the Project is Needed - The Renewable Energy Sector is ripe with opportunity for operational efficiencies. The heavy reliance of costly manpower and outdated tools is a drawback. Airtonomy's platform is transforming Renewable Energy Sector operations by introducing a modern, readily available, cost-effective tool operated by on-site technicians. Such a tool has nearly endless uses. This proposal seeks to increase the value-added nature of Airtonomy through development of additional applications. Each of the following aspects, as well as others, will produce significant cost reductions using the Airtonomy platform to develop corresponding applications.



The following is an Xcel Energy excerpt from a recent submission to the Edison Electrical Institute (EEI):

“In partnership with Evolve Analytics, Xcel Energy is testing using drone technology to estimate the mortality of birds and bats within wind farms. Xcel Energy reports wind turbine-related deaths of birds and bats to the U.S. Fish and Wildlife Service. The current method of discovering the deceased birds and bats is labor intensive. A bird or bat carcass is found by visual inspection of the ground around the wind turbine. A biologist must walk in a grid pattern on the pad to look for carcasses. The distance walked can reach two miles for one wind turbine because of the followed grid pattern.

In collaboration with Xcel Energy's field detection surveys, we would use drones instead of ground crews to conduct bird mortality assessments. Our initial testing would involve multiple surveys at different altitudes once a month throughout the April-November monitoring season to account for vegetation and species diversity changes. In the case of Xcel Energy's Courtenay wind farm, 100 turbines must be examined monthly, resulting in close to 200 miles of walking. Currently, the number of man-hours spent walking the fields is costly. The cost of the program at one wind farm can exceed \$300 thousand annually.

Introducing drones into the wildlife mortality monitoring programs at Xcel Energy wind farms will improve safety, produce more accurate results and reduce cost. It will improve safety by reducing the required walking distance of a biologist in potentially hazardous areas. More accurate results will be

obtained by nature of the potential for drones to fly in the areas that may be temporarily human-inaccessible. Costs will be reduced by reducing the man-hours necessary for these programs. Through this method, the time previously spent by the biologist walking through a field can now be used elsewhere. Also, less staff will be required.

Xcel Energy is also working to develop an automated approach to prevent eagle collisions with wind turbines. In this instance, we would install camera stations on the periphery of the turbines and using a variety of probability models we would decide whether or not a turbine or section of turbines should be shut down to avoid eagle collisions. This system of operations would remove or reduce the need for biologists to sit and observe eagle activity at the site to determine if turbines should be shut down to reduce collisions. Cameras will leverage infrastructure and power resources from equipment already on site for blade inspections.

In the near future, Xcel Energy sees drones becoming commonplace among the tools we use to deliver energy reliably and cost-effectively to our customers. Drones may not only be used for inspection but may eventually be able to assist in repairs to our power lines as the technology evolves. The data collected from the work we are doing will be shared with utilities to help improve operations industry-wide.”

The systems and networks that comprise our society’s and economy’s infrastructure, such as energy, transportation, emergency and health/safety services, finance, and communications are critical to life as we know it.

Natural disasters or deliberate acts of destruction, while relatively rare, can have devastating consequences for life and limb, property, business operations, the economy, and national security. The ability to provide a safe, timely, reliable and efficient response to such disasters is critical to maintaining public confidence and to the nation’s safety, public health, and prosperity. Utilization of unmanned aircraft systems (UAS) to improve the restoration of compromised infrastructure after a natural disaster is consistent with the U.S. Department of Homeland Security’s goals of increasing the security and resilience of America’s critical infrastructure including energy, transportation, communications, and water systems as well as emergency services (including the highest priority lifeline infrastructure).

The proposed project advances the capabilities of Xcel Energy and the Renewable Energy industry as a whole by allowing a timely, efficient, and cost-effective response to natural disasters which will, in turn, provide many significant safety and economic benefits to affected populations. Public and employee safety is a core value at Xcel Energy and a primary concern during emergency response situations. The benefits of preventing any injury or saving a life by being able to respond faster and more effectively to a natural disaster are immeasurable. Considering the high costs of rebuilding power generation and distribution systems and restoring service to their customers typically incurred by electric utilities in the aftermath of large-scale natural disasters, even small gains in the ability to respond has the potential to translate into tens of millions of dollars in savings per large-scale event. There are also intangible benefits; specifically, the ability to safely and efficiently gather the needed quality and quantity of

information quickly without risking the safety of workers represents a substantial technological breakthrough.

Additional benefits of the project for the North Dakota Renewable Energy Sector include:

- Developing capabilities that can be easily leveraged for other infrastructure and disaster response agencies.
- Increasing the viability of UAS application for electric utilities by developing technology (e.g., simplified control systems) needed to reduce the personnel required to deploy and utilize UAS for a variety of utility-related tasks.
- Establishing an initial capability to deploy UAS within a disaster response framework.
- By working collaboratively with government counterparts, cementing North Dakota Renewable Energy's role as an industry leader in implementing UAS as a commercial tool.
- Building a pathway for the continued growth of UAS support to the Renewable Energy industry through technology and regulatory expansion of UAS operations and its related technologies.

Perhaps most impactful, is the growing opportunity for North Dakota to lead the way establishing a bountiful ecosystem for scaled drone use within the Renewable Energy Sector. By treating drones as a tool, the sale of drone/sensor hardware, corresponding software, and custom AI based applications stands to soar. The corresponding economic development is palpable, since awarding of a Phase I Renewable Energy Grant, Evolve Analytics added 12 software development, engineering, and computer science positions were added with plans to more than double that number in 2021. With more than 60,000 turbines domestically, and more than 5 times that many internationally, the impact of this project, namely placing multiple drones on wind sites, each with the ability to perform several critical functions, can be measured in the millions.

Expected Results – Simply put, the result of this endeavor will be daily onsite use of drones by technicians for a wide variety of on-demand, push button applications powered by AI.

STANDARDS OF SUCCESS

Simply put, the standard of success is building upon a Phase I application, by increasing the value added from Airtonomy's platform. This is accomplished by maximizing the application of push-button drones operated by on-site technicians and the corresponding use of artificial intelligence, specifically machine learning and computer vision, to create automated workflows specific to renewable energy sites, starting with wind. Doing so will further revolutionize efficiency of asset inspection and maintenance within the Renewable Energy Sector.

In relationship to the proposal, creation of a viable FAA safety case seeking operation on wind sites is a crucial step toward the ultimate objective of deployment across the spectrum of critical assets including: distribution/transmission, hydroelectric, solar, wind, and substations. Seeking unprecedented approval from the FAA will require a first of its kind approach to demonstration of the corresponding safety case. This is enabled by a full-scale simulation including operational, technical, and environmental elements utilizing Microsoft AirSim; an open-sourced, high-fidelity system for testing the safety of artificial intelligence systems.

The project will address the following elements of Airtonomy applications, which can be considered deliverables:

- **Develop, deploy, test, and commercialize 7 applications built using the Airtonomy platform, that combined will constitute a modern, robust, on-demand tool that technicians can operate with the push of a button.**
- Validate the Federal Aviation Administration safety case and associated simulation through physical testing at the selected ND Renewable Energy site.
- Successfully demonstrate to the Federal Aviation Administration, safe deployment of Airtonomy capabilities to enhance on-demand, push button drone operations on Renewable Energy sites.
- Obtain a permanent Federal Aviation Administration waiver for Airtonomy in relationship to wind energy sites.
- **Seize a first of its kind opportunity by commercializing the Airtonomy solution, operated by on-site technicians (via a permanent FAA operational waiver), with the intention to grow market share within the Renewable Energy and Utility Sector in real-time as the Federal Aviation Administration (FAA) loosens regulations such as Beyond Visual Line of Sight (BVLOS), which are led by the Northern Plains UAS Test Site, thereby allowing drones to operate in civilian airspace.**

BACKGROUND/QUALIFICATIONS

Below the relevant experience of the key participants is summarized. More detailed information on these key people is provided as an attachment.

UND Research Institute for Autonomous Systems (RIAS) - A global leader in unmanned and autonomous systems research, application and policy development, we provide solutions to present and future challenges. The UND Research Institute for Autonomous Systems (RIAS) is built upon the core University of North Dakota values of community, lifelong learning and discovery. With a well-articulated plan, expertise across a broad set of disciplines, and an organized, committed team, we continue to **RIAS** to the challenge of providing autonomous technologies and policies that serve society.

Our mission is simple, create new autonomous systems through multidisciplinary research and lead development of world-changing autonomous policies, with the goal of driving a vibrant, diverse and sustainable economy consistent with ethical and legal standards.

Xcel Energy - Xcel Energy is the largest investor-owned utility in North Dakota. It serves approximately 114,000 customers in the state and maintains 257 circuit miles of electric power lines within North Dakota as well as renewable energy generation sites. Power generation and distribution components may need repair after a major storm, onsite incident, or other natural disaster, resulting in power outages for some of its customers. Restoration in North Dakota can be particularly challenging because the affected infrastructure may be in remote areas that are not readily accessible. Xcel Energy's community, customers, and shareholders will benefit greatly if the company's distribution operations have access to fast, accurate and reliable asset inspections made possible with Airtonomy capabilities during escalated operations as well as for routine operations when major storms or emergencies happen in any part of the North Dakota service territory.

One of the greatest challenges during escalated operations is the up-front damage assessment requiring "boots on the ground" (i.e., foot patrols) in areas of destruction to evaluate damage to the area and equipment and to determine the right materials, equipment, and personnel needed to quickly and safely restore power or functionality. Foot patrols are time-consuming and, depending on the domain and site, can be dangerous.

The length of time required to restore power or functionality during escalated operations is directly a function of the extent and time spent on the damage assessment. The use of Airtonomy will help Xcel Energy significantly speed up this important damage assessment process by providing important information in a quicker and safer manner, thus improving restoration times and reliability for customers. Following Hurricane Sandy, expectations within the industry, by customers and by stakeholders is that power restoration will be better, faster, and safer in the future. This outcome of this project will help Xcel Energy meet these expectations in North Dakota.

Minnkota Power - Minnkota Power Cooperative is a not-for-profit electric generation and transmission cooperative headquartered in Grand Forks, N.D. Formed in 1940, Minnkota provides wholesale electric energy to 11 member-owner distribution cooperatives located in eastern North Dakota and

northwestern Minnesota. These members serve nearly 135,000 consumer accounts in a 34,500 square-mile area, including many of the region's homes, farms, schools and businesses.

Minnkota also serves as operating agent for the [Northern Municipal Power Agency \(NMPA\)](#). Headquartered in Thief River Falls, Minn., NMPA supplies the electric needs of 12 associated municipals that serve more than 15,000 consumer accounts in the same geographic area as the Minnkota member-owners.

Minnkota is committed to delivering safe, reliable, affordable and environmentally-responsible electricity. The primary source of electric generation for the Minnkota member-owners is the Milton R. Young Station, a two-unit, lignite coal-based power plant located near the town of Center, N.D. Minnkota owns and operates Unit 1, while also operating Unit 2 on behalf of [Square Butte Electric Cooperative](#). Square Butte is owned by the cooperatives associated with Minnkota.

Minnkota's electric generation portfolio includes energy purchased from [three North Dakota wind farms](#) and hydroelectricity purchased from the [Garrison Dam](#) in central North Dakota.

In order to deliver power, Minnkota operates and maintains a robust set of electric transmission infrastructure, including more than 3,340 miles of transmission line and 249 substations.

Microsoft Aerial Informatics and Robotics Group - The Aerial Informatics and Robotics (AIR) group builds intelligent and autonomous flying agents that are safe and enable applications that can positively influence our society. The core technology builds upon cutting-edge research in machine intelligence, robotics, and human-centered computation in order to enable an entire fleet of flying agents ranging from micro-UAVs to commercial jetliners.

AIR research approach brings together ideas from machine learning and perception and enables Decision making under Uncertainty for various challenges that arise in AI platforms. The synthesis of algorithms and systems enables aerial vehicles such as quadrotors, soaring gliders, small aircraft, and commercial airliners. Applications scenarios include monitoring for precision agriculture, pathogen surveillance, weather sensing, enabling digital connectivity, etc.

Northern Plains UAS Test Site - North Dakota's Northern Plains UAS Test Site is one of seven FAA-approved UAS test sites. The test sites conduct crucial research to determine how to integrate UAS safely into the national airspace. The Northern Plains UAS Test Site was the first FAA test site to conduct flights, launching its first research flight in early May 2014. The Northern Plains UAS Test Site is headquartered in Grand Forks, ND.

The Northern Plains UAS Test Site will provide support for FAA waiver submission and operations to test concepts and technologies under the proper FAA approval to test this concept of operations. Part 107 does not currently allow for 1-to-many control. This will likely need to be enabled via the Part 107 waiver process. The Northern Plains UAS Test Site has a close working relationship with the FAA and will lead the effort to obtain approval to execute these flights. This likely will require an information exchange between the research team, OEMs, and technology developers with the FAA. The Northern

Plains UAS Test Site will organize the information packet and waiver application to submit to the FAA, which will include a safety risk analysis, initial flight location, and Concept of Operations. As the project and systems mature, the areas of operations may be expandable to other similar locations. This will need to be coordinated with the FAA.

Evolve Analytics - Evolve Analytics (EA), a North Dakota limited liability corporation located in Grand Forks, and supported by the UND Aerospace Foundation, Microsoft TechSpark, the Grand Forks Region EDC, and the City of Grand Forks, was founded in 2018. EA founders have unique experience in unmanned aerial systems, artificial intelligence, and underlying technical framework, specifically in the energy asset inspection industry. Our team comes with deep regional connections, renewable energy expertise, airspace integration, strategic relationships with major technology providers, principals who have successfully launched businesses in similar spaces, and thorough knowledge of the renewable energy industry including key relationships. After a competitive process, Evolve Analytics recently received an inaugural Microsoft TechSpark grant award intended for work with aerial imagery (See Attachment I).

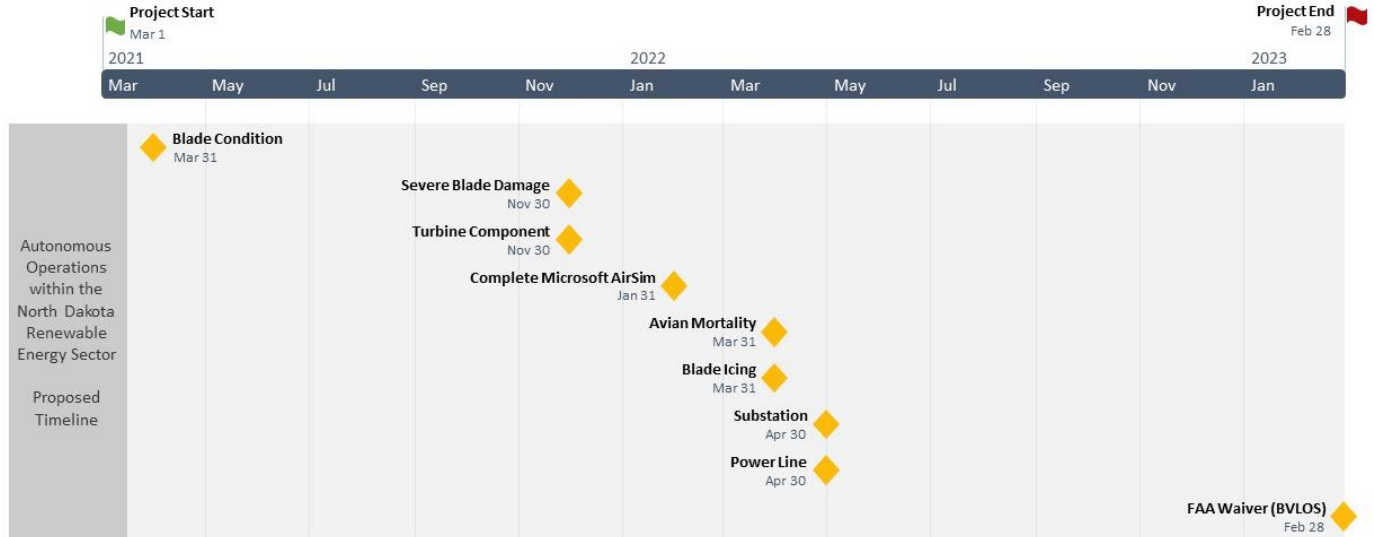
MANAGEMENT

Evolve Analytics will provide the overall project leadership drawing upon the strengths of each participant and subcontractors. The lead person for each is identified in the Background/Qualifications section. Key milestones throughout the project, as shown on the timeline below, will occur as each task is completed and also in a quarterly progress report to the North Dakota Renewable Energy Council.

The UND project manager will be responsible for management of project activities and effective communication between EA, Xcel Energy, Minnkota Power, Microsoft, UND-RIAS, and NPUASTS. The communication plan will include periodic meetings and/or conference calls with team members to allow for the exchange of information and input on planned activities, ensure that the project is progressing according to schedule, and ensure that project goals are being met. Project Team meetings will be held monthly and shall include the personnel from the EA, Xcel Energy, Minnkota Power, Microsoft, UND-RIAS, and NPUASTS that support the project deliverables. Personnel who are unauthorized foreign nationals shall be excluded from all or portions of the project in accordance with United States law regarding access by foreign nationals to equipment covered under the International Traffic In Arms Regulations (ITAR) and Export Administration Regulations (EAR).

TIMETABLE

The tasks and milestones are illustrated in the following figure. To reduce clutter, not all milestones are highlighted.



BUDGET

Evolve Analytics is making a significant investment in this project, including resources raised outside of the scope. A \$2,271,645.00 budget is proposed, of which less than 1/4 of the funding is sought from the North Dakota Renewable Energy Program. The vast majority of funding is cash dedicated to software development, engineering, and hardware creation.

Additionally, it is important to note that above and beyond this proposal, Xcel Energy, Minnkota Power, and Microsoft pledge to contribute Private Sector (Cash Reserved) resources as well that with Evolve Analytics will substantially exceed the required match.

A **detailed budget** is provided as Attachment E.

	NDIC's Share	Applicant Share (Cash)	Applicant Share (In-Kind)
Personnel		\$464,543	\$804,000
Equipment and Materials	\$125,241	\$36,000	
Travel		\$45,050	
Northern Plains UAS Test Site		\$68,811	
Software Development	\$374,759	\$153,241	
Other Direct Costs			\$200,000
GRAND TOTAL	\$500,000	\$767,645	\$1,004,000

Please use the space below to justify project associated expenses, and discuss if less funding is available than that requested, whether the project's objectives will be unattainable or delayed.

Given the significance to primary North Dakota industries (Renewable Energy and Unmanned Aircraft Systems), coupled with the substantial cost assumed by Evolve Analytics, we believe funding of the proposal is value added. However, if grant funding must be reduced, it will increase external funding necessary for the project, thereby potentially limiting scope and/or extending duration. In this event, Evolve Analytics is willing to entertain a lessened target funding number and correspondingly determine the impact.

CONFIDENTIAL INFORMATION

Hardware, software, and AI/ML/CV, including designs and source code that comprise the Evolve Analytics' Airtonomy Platform and all associated outcomes including data, as well as technical partner (Microsoft), will be considered confidential information that needs protection under North Dakota Century Code 54-17.6.

Upon project completion, when the resulting solution goes to market, **ALL** confidential information will be included in the final project summary and can therefore be released to the public.

1. A general description of the nature of the information sought to be protected, **The Evolve Analytics' Airtonomy Platform including hardware and software components.**
2. An explanation of why the information derives independent economic value, actual or potential, from not being generally known to other persons, **The Evolve Analytics' Airtonomy Platform consists of hardware and software components considered intellectual property. Development work with technical partners is under a non-disclosure agreement. Both constitute vital competitive advantages.**
3. An explanation of why the information is not readily ascertainable by proper means by other persons, **The Evolve Analytics' Airtonomy Platform consists of hardware and software components considered intellectual property. Development work with technical partners is under a non-disclosure agreement. Both constitute vital competitive advantages.**
4. A general description of any person or entity that may obtain economic value from disclosure or use of the information, and how the person or entity may obtain this value, **Inspection companies, especially those in the drone-based utility inspection sector, would gain a competitive advantage by having access to intellectual property owned by Evolve Analytics.**
5. A description of the efforts used to maintain the secrecy of the information. **To date, Evolve Analytics has exercised discretion by selectively engaging technical partners, employing non-disclosure agreements, and not sharing its intellectual property, which is being patented.**

PATENTS/RIGHTS TO TECHNICAL DATA

Since this project builds upon existing tools of Evolve Analytics and Microsoft; all reserve the Intellectual Property Rights (IPR) to any tools and results of such tools developed in this project. Furthermore, they reserve the right to use any data from this project for commercial purposes.

Attachment A – Project Fit with ND REC Goals

Project Fit with Goals, Purposes, and Priorities of the North Dakota Renewable Energy Council.

This project is consistent with several goals and purposes including:

- *Promote efficient, economic, and environmentally sound development and use of North Dakota’s vast renewable energy resources, particularly in the areas of wind energy, biofuels (ethanol & biodiesel), and biomass.*
 - On-demand, onsite operation Airtonomy creates an entirely new dynamic within the Renewable Energy Sector. Significant increases to operational efficiencies are profound, as Airtonomy provides an immediate, safe, and cost-effective first-response layer that is autonomous, prompted by control systems as well as the emergency response center, and integrated directly with the enterprise resource management system.
 - Airtonomy also generates new employment opportunities in fast-growing and highly desirable fields such as data science and UAS in North Dakota, helping the region to retain and attract top talent professionals in competitive areas. Presently Airtonomy is growing its full-time staff to 31.
- *Encourage and promote the use of new technologies and ideas that will have a positive economic and environmental impact on renewable energy development and production in North Dakota.*
 - Significant use of sophisticated technologies such as Computer Vision, Machine Learning, Robotics, and Complex Simulation is essential to the enablement of Airtonomy applications deployed in support of North Dakota Renewable Energy sites.
 - Realization of project objectives will further enhance vital North Dakota Renewable Energy and Unmanned Aircraft Systems industries.
- *Create jobs related to the production and utilization of North Dakota’s renewable energy resources.*
 - Success will directly translate to job creation in the Renewable Energy Sector in the areas of manufacturing, construction, training, service, computer science, data science, software development, UAS, engineering, sales, marketing, and management.
- *Ensure economic stability, growth and opportunity in the renewable energy industry.*
 - The Renewable Energy Sector is ripe with opportunity for operational efficiencies. The heavy reliance of costly manpower and outdated tools is a drawback. Airtonomy will further transform Renewable Energy Sector operations by introducing a modern, readily available, cost-effective tool installed onsite.

This project is also consistent with the ND REC priorities such as:

- *Identify and develop renewable energy technologies presently not used in North Dakota.*
 - Technologies developed by this proposal will be first to market within the Renewable Energy Sector.

- *Generate information and knowledge that will have the highest probability of bringing new renewable energy companies and industry investment to North Dakota.*
 - The benefits of realizing this project are profound. Not only will a successful outcome complement current companies within the Renewable Energy Sector, but it also has the potential to generate an entire subset of complementary new ventures including instate manufacturing; and technology, engineering, & computer science careers.
- *Maximize the market potential for renewable energy resources and the associated byproducts produced therewith.*
 - Same answer as above.
- *Have the highest potential for creating new renewable energy jobs, wealth, and tax revenues for North Dakota.*
 - As noted above, innovative application of technologies such as Computer Vision, Machine Learning, Robotics, and Complex Simulation will transform the Renewable Energy Sector with North Dakota at the epicenter.
- *A higher priority will be given to those applications having private industry investment equal to at least 50% or more of total cost.*
 - Evolve Analytics, with private sector partners Xcel Energy, Minnkota Power, and Microsoft, substantially exceed the 50% investment match.

Attachment B – Certificate of Good Standing

State of North Dakota
SECRETARY OF STATE



**Certificate of Good Standing
of
EVOLVE ANALYTICS, LLC**

SOS Control ID#: 0000172458

Certificate #: 019345224

The undersigned, as Secretary of State of the state of North Dakota, hereby certifies that, according to the records of this office,

EVOLVE ANALYTICS, LLC

a Limited Liability Company - Business - Domestic was formed under the laws of NORTH DAKOTA and filed with this office effective October 5, 2018. This entity has, as of the date set forth below, complied with all applicable North Dakota laws.

ACCORDINGLY, the undersigned, as such Secretary of State, and by virtue of the authority vested in him by law, hereby issues this Certificate of Good Standing.

DATE: December 14, 2020

Handwritten signature of Alvin A. Jaeger in black ink.

Alvin A. Jaeger
Secretary of State

Attachment C – Bios of Key People

UND Wildlife Biology Lab

Dr. Susan Ellis-Felege is an Associate Professor of Wildlife Ecology and Management at the University of North Dakota. She has expertise in the development and applications of technology, especially drones and AI, into solving applied questions in the field of wildlife ecology with expertise ranging from threatened and endangered species, game species, and overabundant species that span from Arctic ecosystems in Canada to the Northern Great Plains to the southeastern pine forests. Her recent work with the team is resulting in the development of a wildlife services company that uses enabling technology described in this proposal to enable industry to meet regulatory standards for monitoring and mitigating wildlife. Susan will serve in that role as the team validates the tools developed in this proposal and works with regulatory agencies to adopt these new tools as a new industry standard.

UND – RIAS

Dr. Mark Askelson is a Professor of Atmospheric Sciences at the University of North Dakota. He has over 20 years of research and applications experience with weather radar, including advanced applications involving radar polarimetry and phased array technologies. His areas of expertise include radar meteorology, numerical weather prediction, data assimilation, and unmanned aircraft systems (UASs). His current foci include the use of phased array radars in aircraft deconfliction systems for UASs and the use of cooperative information to enable deconfliction of unmanned aircraft with other aircraft. Dr. Askelson has led multiple UAS research efforts, including multimillion-dollar research efforts, focused on integration of UAS into the National Airspace System using both ground-based phased-array radars (development of the Ganged Phased Array Radar-Risk Mitigation System; GPAR-RMS) and cooperative data (the Limited Deployment-Cooperative Airspace Project; LD-CAP). He is currently a lead in the ASSURE "Small UAS Detect and Avoid Requirements Necessary for Limited Beyond Visual Line of Sight (BVLOS) Operations" effort.

Northern Plains UAS Test Site

Chris Theisen graduated from the University of North Dakota (UND) with a B.S. (May 2003) and M.S. (May 2006) in Atmospheric Sciences. During his M.S. studies, he specialized in polarimetric radar meteorology with an emphasis on cloud microphysics while also working as a weather forecaster for Meridian Environmental Technology, Inc. He then joined the faculty of the Atmospheric Science Department at UND (August 2006) as a temporary instructor of radar meteorology. In June of 2007, Mr. Theisen became a full-time staff member of the Regional Weather Information Center at UND. As of January 2014, he assumed duties and responsibilities of the Director of Research and Development for the Northern Plains Unmanned Aircraft Systems Test Site (NPUASTS) and joined full time with the NPUASTS in December 2018. He plays an active role in planning and overseeing research performed at the NP UAS TS. He works closely with NPUASTS research partners (UND & NDSU) as well as with industry to perform research to integrate UAS safely into the NAS. Mr. Theisen has a solid knowledge base on UAS technologies, regulations, applications, and capabilities. He also has a strong background in radar meteorology including Doppler, polarimetric and phased array radar applications. His other areas of

interest include radar weather applications, autonomous vehicle applications and technologies, airspace visualization systems, and sensor data fusion applications.

Xcel Energy

Eileen Lockhart leads Xcel Energy's Unmanned Aircraft System (UAS) program. She has been involved with the UAS program since its inception and has served as the program manager for the last two years. Xcel Energy was the fourth utility to obtain FAA approval for UAS missions. Eileen leads Xcel Energy's multidisciplinary UAS team and business focused UAS operations. The UAS team has successfully executed several proof of concept missions spanning Xcel Energy's electric transmission & distribution, high pressure gas transmission & distribution, and generation operations to demonstrate that the technology can successfully improve safety and productivity across a number of businesses. Under Eileen's leadership, the UAS team developed a governance framework, ensuring Xcel Energy is compliant with all federal and local regulations, and recently completed the first beyond-line-of-site mission in the history of the U.S. electric utility industry. Eileen joined Xcel Energy in 2011. She represents Xcel Energy on the EEI Unmanned Aircraft Systems team, IEEE UAS team, NYSERCH UAS team and is involved in EPRI's UAS tailored collaboration project. When she is not developing UAS missions and governance, Eileen enjoys spending time outdoors and with her family.

Mark Nisbet is the North Dakota Principal Manager for Xcel Energy, the fourth- largest combination natural gas and electricity company in the nation; serving 3.3 million electricity customers and 1.8 million natural gas customers in eight Western and Midwestern states. In 2018, Xcel Energy is breaking ground on the Foxtail Wind Farm in Dickey County which will bring Xcel Energy to 500 MW of owned wind plus 112 MW of purchased wind power in North Dakota. Mark has shown a personal commitment to renewable energy by installing 40 KW of solar panels on his farm and purchasing the all-electric Chevy Bolt. Mark serves on the board for the North Dakota EmPower Commission, North Dakota Renewable Energy Council, the West Fargo Economic Development Authority and incoming Chair for the Fargo Moorhead Chamber of Commerce. He also has served as chairman of the governor's Centers of Excellence Commission, and was the 2016 United Way of Cass Clay Campaign and United Way Board member. Mark received a bachelor's degree in business administration from Minnesota State University, Moorhead. He is a graduate of the Minnesota Management Institute at the Carlson School of Business, University of Minnesota. Mark lives in Fargo with his wife, Sandy and they have three sons.

Microsoft

Ashish Kapoor, Principal Researcher & Research Manager – I am a Principal researcher with the Adaptive Systems and Interaction Group at Microsoft Research, Redmond. My research focuses on Machine Learning, Computer Vision, Robotics and Quantum Computation. My recent work has focused on the use of near-realistic simulation to build ML/AI systems.

Jim Piavis, Principal Program Manager – R&D-focused professional leading various operational and development projects including, simulations and synthetics, Geographical Information Systems, Unmanned Autonomous Systems, logistics, and customer facing digital products.

Evolve Analytics

The Evolve Analytics team is comprised of a wide array of seasoned and talented individuals, including substantial experience with large technology companies including Adobe, Microsoft, and Spotify. Collectively, Evolve Analytics is well positioned to achieve grant objectives with demonstrated capability to deliver results with complex product development and commercialization. The UND Aerospace Foundation, the nation's leading provider of flight training services, is Evolve Analytics' partner and provides unparalleled access to resources including staff and equipment. Contributing organizations include award winning development teams from Insight (Blue Metal), Flytbase, the Center for Advanced Design, and Level 12, as well as corporate resources from Xcel Energy and Microsoft. Evolve Analytics is also in the process of expanding its team with an emphasis on software engineering and data science.

(CEO) **Dr. Joshua M. Riedy** – Josh has expertise as a Chief Operating Officer in the renewable energy inspection sector and more than 15 years of expertise managing complex, multi-party technology projects, coordinating government agencies, higher education systems and private parties. As a former CIO and with a software development background, Josh is proficient in the areas of research computing, IT architecture, and development. He also has substantial drone knowledge having received grant funding from notable organizations including the North Dakota Department of Commerce, Bill & Melinda Gates Foundation, and National Science Foundation.

(COO/CMO) **Beth Davis** – Having served as a Senior Vice President at Adobe, Beth has experience conceiving, launching and exiting multi-million dollar technology products and businesses. She was the founder of a predictive analytics business and has overseen the development, management and commercialization of large, national datasets. Beth demonstrated expertise in launching new products into emerging market segments, exemplified in her increasing responsibilities for product development at Macromedia that contributed to Macromedia's ultimate acquisition by Adobe for \$3.4B.

(Vice President of Flight Operations) **Dr. Jim Higgins** – Jim is an aviation industry expert, with more than 15 years direct experience as a pilot, instructor, and professor with project and research expertise in air traffic safety and Unmanned Aircraft Systems, including drones use in power industry inspections. In his role, Jim will be our conduit with standards organizations, monitor and respond to federal and local policy, and set approach to flight given current and evolving regulatory conditions.

(Chief Computer Science Officer) **Dr. Travis Desell** – Travis has overseen and managed large, big data and predictive analytics projects, including a mission critical system for FedEx, similar in nature to Airtonomy. He is a prior awardee and technology specialist on NSF grants and is a recognized expert in programming, Java and C++. Travis has been a professor of Computer Science at UND and Rochester Institute of Technology. In his role as Lead Developer, Travis will be responsible for integrating the systems developed by 3rd party partners and our CCS and delivering the user experience layer as well as the underlying models and applications for measuring, storing, analyzing and reporting on the data generated during inspections.

Attachment D – Letters/Statements of Support



NORTHERN PLAINS UNMANNED AIRCRAFT SYSTEMS TEST SITE

4201 James Ray Drive
Grand Forks, ND 58202



December 11, 2020

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840
kfine@nd.gov

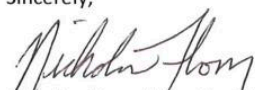
RE: LETTER OF SUPPORT, IN RESPONSE TO THE PROPOSAL BEING SUBMITTED BY AIRTONOMY FOR A RENEWABLE ENERGY GRANT THROUGH THE NORTH DAKOTA INDUSTRIAL COMMISSION

Dear Ms. Fine:

The Northern Plains Unmanned Aircraft Systems Test Site (NPUASTS) is excited to partner with the University of North Dakota, Airtonomy, Microsoft, and Xcel Energy to expand on research using UAS to support the energy sector. The NPUASTS is dedicated to support UAS initiatives within the state of North Dakota and nationwide.

As this project expands on all the progress made by the team today, it will certainly continue to increase the use of UAS in the energy sector on a regional and national level. The NPUASTS looks forward to collaborating with the team under this research effort. We can provide the research team support for National Airspace System access through a Part 107 waiver approval from the FAA. Our relationship with the FAA puts us in a great position to achieve approval for these complex operations expected as part of this proposal. We feel that supporting this project is would help push the industry forward to support these types of operations. We look forward to working with Airtonomy and their industrial application of drone technologies within the Renewable Energy sector.

Sincerely,


Nicholas Flom, Executive Director
Northern Plains UAS Test

NPUASTS.com

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840
kfine@nd.gov

RE: Autonomous Operations within the North Dakota Renewable Energy Sector

The University of North Dakota (UND) Research Institute for Autonomous Systems (RIAS) is excited to partner with Evolve Analytics to further support development of transformative technologies involving drone operations (application of simulations and AI to wind turbine inspections, icing detection, Beyond Visual Line Of Sight operations, etc.) within the renewable energy sector. As an active participant in Phase I research, building upon Evolve Analytic's success with the likes of Xcel Energy, Minnkota Power, and Microsoft is a rare opportunity for North Dakota. UND RIAS acknowledges its responsibility for supplying expertise to enable this endeavor.

We look forward to working with Evolve Analytics to develop these applications of drone technologies within the Renewable Energy sector. The outcomes will help improve productivity and reliability of power generation and distribution systems, which will provide significant benefit to energy customers.

Sincerely,



Mark Askelson
RIAS Executive Director



P.O. Box 2747
Fargo, ND 58108

December 30, 2020

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840
kfine@nd.gov

RE: Autonomous Operations within the North Dakota Renewable Energy Sector

Xcel Energy is excited to continue a partnership with Evolve Analytics, the University of North Dakota, specifically the Research Institute for Autonomous Systems (RIAS), and Microsoft. The commercialization of secure, autonomous, multi-drone operations using Airtonomy's platform will constitute a modern, robust, on-demand tool that technicians can operate with the push of a button. This undoubtedly will further solidify North Dakota as the epicenter for unmanned aircraft systems (UAS) innovation.

Evolve Analytics has demonstrated the ability to deliver results with complex product development and commercialization, backed by the success of a previously awarded Renewable Energy grant. Eileen Lockhart, UAS Program Manager, and I are supportive of a phase II project to build out a suite of applications on the Airtonomy platform and look forward to the prospects it will have for the State of North Dakota as well as within the Renewable Energy industry.

Xcel Energy acknowledges its responsibility toward supplying company personnel and expertise to see the endeavor through as well as access to select company sites and integration with various control systems. Upon realization of this project, Xcel Energy intends to utilize the developed suite of applications to support safe data collection of our company property and assets. Added benefits such as technician safety, site security, and wildlife impact mitigation are vital as well.

We look forward to working with Evolve Analytics and their industrial application of drone technologies within the Renewable Energy sector. Specifically, the outcome will help us improve productivity and reliability of our system which will in turn benefit our customers by continuing to keep energy costs low.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Mark Nisbet'.

Mark Nisbet
Xcel Energy
North Dakota Principal Manager
2302 Great Northern Drive, Fargo, ND 58102
P: 701.241.8607 C: 701.371.5255
E: mark.nisbet@xcelenergy.com

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 936 7329
<http://www.microsoft.com/>



Jan 27, 2021

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840
kfine@nd.gov

RE: Autonomous Operations within the North Dakota Renewable Energy Sector

Microsoft is pleased to continue a partnership with Airtonomy (and it's parent company, Evolve Analytics), the University of North Dakota, specifically the Research Institute for Autonomous Systems (RIAS), Minnkota Power and Xcel Energy further supporting development of transformative technologies inherent to end-to-end, "push button", autonomous inspection solutions.

Microsoft looks forward to building on the success of a previously awarded Phase I Renewable Energy grant, and is supportive of a Phase II project to build out a suite of autonomous drone inspection solutions on the Airtonomy platform. Microsoft will engage in research via company personnel and technical skills to see the project through, specifically with regards to technical expertise supporting AirSim functionality and feature capability, enabling safe unmanned aircraft system (UAS) autonomous operations.

We look forward to working with UND, Airtonomy/Evolve Analytics and Xcel Energy and we strongly feel that the research generated will benefit the growth of our business, the community, and will increase our knowledge base, and help commercialize and scale the use of unmanned aircraft systems across the industry.

Sincerely,

A handwritten signature in black ink, appearing to read "Ashish Kapoor".

Ashish Kapoor,
Partner Research Manager
Microsoft Corporation, 1 Microsoft Way,
Redmond, WA 98052

Email: akapoor@microsoft.com
Phone: +1-425-704-7857



5301 32nd Ave S
Grand Forks, ND 58201-3312
Phone 701.795.4000
www.minnkota.com

A Touchstone Energy® Cooperative 

January 5, 2021

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept. 405
Bismarck, ND 58505-0840
kfine@nd.gov

RE: Autonomous Operations within the North Dakota Renewable Energy Sector

Minnkota Power Cooperative is excited to partner with Evolve Analytics, the University of North Dakota, specifically the Research Institute for Autonomous Systems (RIAS), and Microsoft. The commercialization of secure, autonomous, multi-drone operations using Airtonomy's platform will constitute a modern, robust, on-demand tool that technicians can operate with the push of a button. This undoubtedly will further solidify North Dakota as the epicenter for unmanned aircraft systems (UAS) innovation.

Evolve Analytics has demonstrated the ability to deliver results with complex product development and commercialization, backed by the success of a previously awarded Renewable Energy grant. As the Minnkota Power Cooperative CEO, I support this project and look forward to the prospects it will have for the State of North Dakota as well as within the energy industry.

On behalf of Minnkota Power Cooperative, I am pleased to offer a 1:1 cash match in support of the Renewable Energy Grant. Additionally, Minnkota Power Cooperative acknowledges its responsibility toward supplying company personal and expertise to see the endeavor through as well as access to select company sites and integration with various control systems. Upon realization of this project, Minnkota Power Cooperative intends to utilize the developed suite of applications to support safe data collection of our company property and assets. Added benefits such as technician safety, site security, and wildlife impact mitigation are vital as well.

We look forward to working with Evolve Analytics and their industrial application of drone technologies within the energy sector. Specifically, the outcome will help us improve productivity and reliability of our system which will in turn benefit our members by continuing to keep energy costs low.

Sincerely,

A handwritten signature in blue ink, appearing to read "Mac McLennan", with a long horizontal flourish extending to the right.

Mac McLennan
President and CEO
Minnkota Power Cooperative, Inc.

Attachment E – Detailed Budget

EVOLVE ANALYTICS, LLC

PROJECTED DATES: 1 March 2021 – 28 February 2023

Personnel	NDIC's Share	Applicant Share (Cash)	Applicant Share (In-Kind)
Project Director (25%)			72,000
Operations (25%)			36,000
Software Developer (100%)			312,000
Computer Scientist (100%)			384,000
UND Biology		46,000	
UND RIAS		418,543	
TOTAL PERSONNEL		464,543	804,000
EQUIPMENT & MATERIALS	125,241	36,000	
UND Biology		34,000	
UND RIAS		2,000	
Drone and Accessories (x4)	125,241		
TRAVEL		45,050	
Northern Plains UAS Test Site		68,811	
Software Development	374,759	153,241	
OTHER DIRECT COSTS			200,000
Airtonomy Platform			200,000
GRAND TOTAL	\$500,000	\$767,645	\$1,004,000

Evolve Analytics Funding Match Description

Personnel

An average weighted salary for various positions was used for budgeting, and fringes of 20% have been added to that figure. UND items are included in Attachments F & G. A total of \$1,268,543.00 is allocated for private sector personnel.

Equipment & Materials

UND specified equipment and materials. A total of \$36,000 is allocated for private sector equipment.

Travel

Mileage and occasional overnight travel for partner meetings and to remote locations (EA, UND) as well as housing for Avian Mortality. Private sector cash reserved for travel will total \$45,050.

Software Development

Third party software development for advanced simulation (AirSim). A total of \$153,241 is allocated for private sector software development. *Note: If possible, EA will move this to in house development.

Northern Plains UAS Test Site

A subcontract to the Northern Plains UAS Test site is included to enable development of a BVLOS safety case for the FAA. A total of \$68,811 is allocated for private sector software development.

Other Direct Costs

The Airtonomy Platform consisting of ROS application, UWP application, Azure IoT framework, Azure, AI/CV, and optimization algorithms. A total of \$200,000 is allocated for private sector systems. This number is predicated on 2500 turbines per year at \$400/turbine for two years, which is retail price.

Requested Renewable Energy Program Funding Description

Equipment & Materials

Drones (see Attachment H) and accessories. The total amount requested is \$125,241.

Software Development

Third party software development for advanced simulation (AirSim). The total amount requested is \$374,759. *Note: If possible, EA will move this to in house development.

Attachment F – UND Proposal (Autonomous Applications)

Budget Justification

University of North Dakota

Autonomous Operations within the North Dakota Renewable Energy Sector

Anticipated Period of Performance: 3/1/2021–2/28/2023

Personnel:

Salary is being requested for the faculty PI (\$48,368 for 4 months of effort), faculty Co-PI (\$18,113 for 1.4 months of effort), post doctorate researcher (\$16,177 for 4 months of effort), project manager (\$15,776 for 3 months of effort), and three graduate students, each having an estimated stipend of \$32,657 in both years for a total of \$195,940 (3 students x 2 years). Total salary for all personnel is \$294,373 for the project duration to support project objectives.

Fringe benefits:

Amounts shown for fringe benefits are estimates determined using historical data and are provided for proposal evaluation purposes only. Actual fringe benefit costs will be charged to the grant according to each employee's actual benefits. Fringe benefits are estimated at 34% for faculty, 54% for staff and 8% for students. Total estimated fringe for the project is \$55,533.

Travel:

Travel is estimated at \$4,050 to support 1 week of travel for 3 people to support testing and system equipment installation. The breakout is \$150/night lodging for 5 nights and 3 people (\$2,250), \$70/day for meals & incidental expenses for 5 days and 3 people (\$1,050), \$250/week for a rental car and three rental cars (\$750).

Subcontract:

A subcontract to the Northern Plains UAS Test site of \$68,811 is included to enable development of a BVLOS safety case for the FAA.

Equipment:

No major equipment is requested by UND.

Supplies/Minor Equipment:

\$8,560 is requested for supplies/minor equipment. This includes 2 cameras at \$110 each, 2 sets of temperature and dewpoint temperature sensors at \$30 for a set, 2 Rosemount ice detectors at \$3500 each, 2 data loggers at \$350 each, miscellaneous brackets for \$100, and install costs of \$480.

Tuition Remission:

Tuition Remission is estimated for the graduate students at \$11,215/student in the first year and \$11,664 in the second year. Estimates are based upon an average credit cost of \$747.68 for the first year and a 4% increase (\$777.58) in the second year. Tuition Remission is for 15 credits per year. The total tuition remission is \$68,637.

Attachment G – UND Proposal (Avian Mortality)

Wildlife Monitoring – Validation of Drone and AI Approaches to Post-Construction Mortality Monitoring

Renewable Energy Grant

Susan Ellis-Felege

In collaboration with Airtonomy, the UND Biology team has been working to develop drone and AI approaches for conducting post-construction mortality monitoring (PCMM) at newly operational wind farms in order to aid industry in meeting regulatory requirements under the Migratory Bird Treaty Act and the Bald and Golden Eagle Act. In January of 2020, we were awarded a 15-month Research ND grant through the Department of Commerce and a Phase 1 Renewable Energy Grant to develop AI models for automated drone mortality surveys. These drone surveys would leverage Airtonomy's drone-based infrastructure survey approach and enabling technology to facilitate multiple uses of drones for wind energy.

PCMM is required for all new wind farms for a minimum of 1 year of intense surveys after the site becomes operation and often may have as much as 3 years of monitoring depending on the pre-construction assessment of types of wildlife present and risks to those species from the construction. Traditionally, these surveys are conducted by biologists that walk grids equating to approximately 200 miles/month at a site with 100 turbines in search of bird and bat fatalities. This work is mundane and physically demanding, can be challenging wet and cold conditions, and can be costly to conduct. The use of a drone equipped with AI would allow automation of identification of carcasses so that they can be quickly picked by a technician (biologist or wind technician) as part of the regulatory requirements.

Our work to date has focused on: 1) automation to drone flights that are capable of navigating around an operational turbine, 2) collection of training data (images with associated labels of carcasses and debris that could be mistaken for carcasses), 3) development of a trained neural network that is generalizable to other species and areas, and 4) regulatory agency acceptance of this approach. To do this we have conducted flight operations at Xcel Energy's Foxtail site to collect actual wind turbine mortalities and flight logs associated with automated drone operations around turbines. In addition, we have conducted flights at several off-site locations where we create simulated mortalities with available carcasses to enhance the amount and variety of backgrounds and species for our model training data.

Based on more than 430 flights at Xcel Energy's Foxtail site, we have developed the necessary flight routines to be able to conduct PCMM around operational turbines based on a push-button approach allowing for the surveys to be conducted by any of the wind technicians already conducting infrastructure surveys. Airtonomy's team has utilized the rich training dataset we have amassed and created a modeling framework for detecting carcasses that has fairly high detections (~90%) with few false positives (less than 10%). We are continuing to refine these models, but excited about the success compared to traditional foot searches by biologists which may result in detections of small carcasses averaging 27% and 87% detection for larger birds. **As a direct result of the project's success the lead PI**

for wildlife assessments, Dr. Ellis-Felege, has initiated the process of establishing a consulting company that uses Airtonomy's enabling technology to provide services for wind industry in meeting wildlife regulatory standards. Dr. Ellis-Felege is currently working with the University of North Dakota's Center for Innovation to launch this company in January of 2021. Thus, the Phase I grant was directly responsible for the success of not just 1, but 2, start-up companies working together and using drone and AI technologies to benefit industry in North Dakota.

Given our success, we are poised to plan our next step of model validation, where we can verify our drone flight routines and associated AI image processing are able to be adopted into the commercial sector. To do this, we need to conduct additional drone surveys at more sites than Foxtail to be sure the applications can be used broadly across North Dakota and eventually the United States at a variety of wind energy sites and to do some of the direct comparisons of ground searches to drone surveys to facilitate the business model.

We propose to conduct validation of our Automated Drone Post-Construction Mortality Monitoring to accomplish the next steps by:

1. Flying weekly surveys from 15 March until 15 November in collaboration with ground crews at the site to demonstrate direct comparisons of our automated drone protocol to traditional ground surveys. Such a demonstration will be necessary for regulatory agencies to approve this method in place of traditional ground searches.
2. Collect aerial imagery of species not available at the Foxtail site to facilitate generalizing the model to sites across different sites in North Dakota and regions of the United States
3. Refine a current collection application (app) that is in development with Airtonomy for collection of carcasses by technicians that will facilitate species identification verification and allow us to continue to train the AI to increase detections and reduce false positives.
4. Use the information above to produce a PCMM report following the guidelines that current consultant's use to meet U.S. Fish and Wildlife and other regulatory agency requirements to demonstrate comparable information and effort needed to do this with drones












Budget:

Project Manager (Dr. S. Felege) Salary: \$10,000 for 1 month salary
Lead Technician: \$22,500 (salary and fringe for field survey and reporting)
Supporting Technician: \$13,500 (salary and fringe for field assist)
Housing: \$9,000* for 9 months of housing
Travel: \$8,000** in travel expenses to include mileage and per diem
Equipment: \$2000 (miscellaneous supplies, replacement equipment)
Total: \$65,000

*Assuming the chance of renting a house in the area for multiple people (infrastructure and wildlife) and that enables reduced travel back and forth.

**Depending on covid, this expense was much higher than anticipated for us so I am going to toss a little higher number out there, not knowing how quickly we can resume "more normal" approaches to business.

Attachment H – Drone and Accessories

ITEMS	PRICE	TAX	QTY	ITEM TOTAL
 Zenmuse H20 SP Combo (CP.ZM.00000119.01)	\$3,639.00	\$263.83 \$18.20	1	\$3,639.00
 DJI MATRICE 300 SERIES - BS60 Intelligent Battery Station (CP.EN.00000224.01)	\$1,200.00	\$87.00 \$6.00	1	\$1,200.00
 OSDK Adaptor Kit (CP.EN.00000268.01)	\$225.00	\$16.31 \$1.13	1	\$225.00
 DJI MATRICE 300 SERIES-PART08-TB60 Intelligent Flight Battery (CP.EN.00000262.01)	\$700.00	\$50.75 \$3.50	10	\$7,000.00
 DJI MATRICE 300 RTK (SP) (CP.EN.00000221.01)	\$10,599.00	\$768.43 \$53.00	1	\$10,599.00
	1/2			
 Livox Avia LiDAR	\$1,600.00	\$116.00 \$8.00	1	\$1,600.00
 DJI Tripod for RTK Ground Station (CP.AG.00000002.02)	\$180.00	\$13.05 \$0.90	1	\$180.00
 DJI RTK2 Ground Station (CP.EN.00000131.01)	\$3,600.00	\$261.00 \$18.00	1	\$3,600.00
 DJI Matrice 300 RTK - Dual Gimbal Connector (CP.EN.00000265.01)	\$250.00	\$18.13 \$1.25	1	\$250.00
 DJI X-Port (CP.EN.00000227.01)	\$390.00	\$28.28 \$1.95	1	\$390.00
 DJI Cendence Battery (CP.BX.000229)	\$59.00	\$4.27 \$0.29	4	\$236.00
			Subtotal	\$28,919.00
			Shipping	\$150.00
			State Tax Estimate	\$2,096.64
			County Tax Estimate	\$144.61
			TOTAL (USD)	\$31,310.25



AUTOMATED WIND SITE SERVICES AND DATA STRATEGY

Gray Byers | Program Manager, Business Innovation

OCTOBER 5, 2020



APPLIED UAS INNOVATION

Accelerating the Future of Safe, Reliable & Affordable Energy



**DIGITAL TWIN
SIMULATION ENVIRONMENT**



**AVIAN MORTALITY
STUDIES**



**BLADE INSPECTION /
ICING MODEL**

Digital Twin Simulation

Developed with Microsoft AirSim, drones are trained in simulation using onboard computer vision & machine learning for repeatable data collection of assets & no human involvement.

Simulation in "digital twin" environments are used to improve flight routine safety and reliability, aiding in FAA regulatory approval.

Key Benefits

- Cost Reduction
- Risk Free Testing Environment
- Optimal Planning Methodology
- Supports Dataset Building
- Supports Neural Network Training



AUTOMATED AVIAN MORTALITY STUDIES



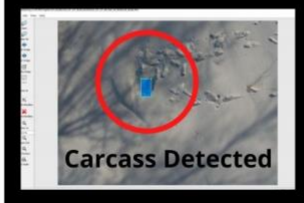
CURRENT SOLUTION

Time Consuming
Prone to Error & Fatigue
Not Cost-Effective



AUTOMATED UAS SOLUTION

Drones Improve Efficiency
AI is Accurate & Consistent
Drones + AI are Cost-Effective



PRELIMINARY TRAINING

On-Site
384 Flights, 35 Carcasses, 8 Species, 5 Species Groups
Off-Site
56 Flights, 806 Carcasses, 50 Unique Species
Neural Network Testing Results
Overall Detection: 95% Recall, 96% Precision
Species-Level Detection: 60% Recall, 60% Precision

PLANNING METHODOLOGY

Built on top of a visually realistic physics engine enables the gathering of accurate visual and numerical data, allowing for optimum planning path algorithms.

AUTOMATED FLIGHT

Autonomous drone inspections occur while turbines are powered, flying transect, 30 ft above ground level, within a 120 x 120 m area around the turbine. AI identifies conditions.

POST-FLIGHT DATA PROCESSING

Images captured during inspection are labeled according to species, sex, carcass condition, etc. Results are fed back into the AI model for further neural network training.

BLADE INSPECTION

Airtonomy is a platform with modular architecture & 'plug in' AI models for various use cases.

PUSH-BUTTON SIMPLICITY

Airtonomy's platform enables complicated, drone-based inspection of energy infrastructure and parallel use cases with the **push of a button** and **no human intervention**.

EDGE COMPUTE

Applications such as Blade Icing require real-time situational awareness that is accommodated by edge compute.

AIRTONOMY PLATFORM



A Digital Data Strategy



EDGE COMPUTE / IoT FRAMEWORK

Data Acquisition --> Real Time
Edge Analysis, Security and
Authentication



ANALYTICS

Computer Vision / Machine
Learning



DATA INTEGRATION

Edge Data/Analysis Integration
With Backend Systems
(e.g. SCADA and SAP)



DATA VISUALIZATION

Operational/Business
Intelligence, Simulation

XCEL ENERGY DRONE PROGRAM DATA MANAGEMENT



EDGE DATA MANAGEMENT LAYER

PACKAGE, TRANSPORT, PROCESS LAYER

WORKFLOW INTEGRATION LAYER

DATA FUSION LAYER

VISUALIZATION LAYER



DIGITAL WIND FARM



A true digital twin, repeatable across all asset types and data models, featuring intelligent autonomous operation, SCADA integration, operating parameters, and remote auto-dispatch.



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