North Dakota Renewable Energy Program
Status Report

Recipient: Evolve Analytics, LLC
Contract Number: R-040-050
Report for time period of: 1/01/20 to 1/31/20

This report was prepared by Evolve Analytics, LLC pursuant to an agreement with the Industrial Commission of North Dakota, which partially funded the project through the Renewable Energy Program.

Evolve Analytics, LLC or any of its subcontractors, and the Industrial Commission of North Dakota, or any person acting on its behalf, do not:

(A) Make any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately-owned rights; or

(B) Assume any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the Industrial Commission of North Dakota. The views and opinions of authors expressed herein do not necessarily state or reflect those of the Industrial Commission of North Dakota.

Description of Project
Please provide a brief description of the project:

This project will help develop Airtonomy, an autonomous, multi-drone operations solution that will be installed onsite in a custom drone housing unit. It will be powered by solar energy and operated remotely. The project includes development of both hardware and software. Software components include technician field application improvements, web application, and on-drone modules.

This technology, which Xcel Energy plans to utilize once it is developed, has the potential to revolutionize the wind industry in terms of: wildlife mortality monitoring and mitigation, routine inspection and maintenance, and safety and security. Utilizing drones and artificial intelligence will reduce the number of manhours required walking in areas that can be dangerous or inaccessible. It has the potential to decrease costs of monitoring significantly. Inspections of turbines can take place when blades aren't moving due to a lack of wind, thereby reducing scheduled downtime and increasing productivity.

Project Tasks
Please describe the progress on all project tasks achieved during the reporting period:

- Selection of site/domain
    - Progress achieved: This task has been accomplished. EA, UND-RIAS, Northern Plains UAS Test Site, and Xcel Energy all agree to a specific 1.75 x 1.75 mile portion of a North Dakota Renewable Energy site.

- ***Progress achieved: This task has been accomplished. EA, UND-RIAS, Northern Plains UAS Test Site, and Xcel Energy all agree to begin intermediary field tests for multi-drone, within visual line of sight at Xcel Energy sites in Colorado and Texas beginning Q1 2020 or upon FAA approval.***

- Safety case justification functional elements document
  - Progress achieved: Three primary tasks are ongoing. The first is creation of a Technical Architecture in collaboration with corporate partners. This document is in draft format, being reviewed by Xcel Energy, UND-RIAS, and the Northern Plains UAS Test Site. The final version is slated for completion in September 2019. The second task is exploratory work with a corporate partner and Xcel Energy. The objective is to ensure initial system configuration is satisfactory for the FAA Safety Case and Concept of Operations. This work is ongoing with anticipated completion Fall 2019. The last task is determination of required flights of the core Airtonomy solution to be completed on Xcel Energy renewable energy sites. Due to pending winter weather, these flights will need to occur outside of North Dakota as well. This work will be ongoing through Spring 2020.
  - Progress achieved: The Northern Plains UAS Test Site recommended a three-step sequence to obtain FAA operational waivers.
  - Progress achieved: The Northern Plains UAS Test Site, Xcel Energy, UND-RIAS, and Airtonomy met to discuss and approve the following:
    - Technical Architecture
    - Three-step sequence to obtain FAA operational waivers
    - Creation of initial Safety Case and Concept of Operations by 12/1/19.
    - Scaled testing of Airtonomy solution.
  - Progress achieved: The Northern Plains UAS Test Site, Xcel Energy, UND-RIAS, and Airtonomy are nearing completion of an initial operating waiver for multi-drone, within visual line of sight for submittal to the FAA.
  - ***Progress achieved: On behalf of Airtonomy, the Northern Plains UAS Test Site submitted an operating waiver for multi-drone, within visual line of sight to the FAA for testing on an Xcel Energy site with assistance from UND-RIAS.***

- Software development
  - Progress achieved: Development of control system software is ongoing with progress primary attributed to technical architecture required by the FAA as well as continued development of the control system, in particular the drone-based software and corresponding cloud DevOps environment. Software development will be ongoing through Fall 2020.
  - ***Progress achieved: Ongoing development***

- Completed set of simulations of chosen scenarios
  - Progress achieved: The Microsoft AirSim simulation, which is pivotal for to the FAA Safety Case, is currently under development. The anticipated completion timeline is Fall 2019. A portion of the simulation work will be displayed within the Fargo Microsoft Innovation Center beginning in October.
  - Progress achieved: Microsoft AirSim simulation development was presented for review by UND-RIAS and Airtonomy. A draft of simulation work to be displayed within the Fargo Microsoft Innovation Center in October has been created.

    - Progress achieved: Final adjustments were made to Microsoft AirSim simulation development based upon feedback. A draft of simulation work was presented on the Fargo Microsoft Campus at 1 Million Cups.
    - Progress achieved: Initial development is now in the hands of UND-RIAS for implementation. Documentation is still being finalized.
    - ***Progress achieved: Airtonomy is working with Xcel Energy and Microsoft to expand simulation to cover a broader selection of power assets.***

- Safety case and CONOPS approval
    - Progress achieved: TBD

- Buildout of corresponding hardware/software solution
    - Progress achieved: EA has engaged with ComDel, Northern Valley Machine, and the University of North Dakota regarding hardware design. Microsoft is also being consulted regarding use of FarmBeats. This task will be ongoing through Spring 2020.
    - Progress achieved: Conceptual design elements of the housing unit or "nest" were presented to Xcel Energy, Microsoft, and Airtonomy. A corresponding senior design project was initiated with the University of North Dakota.
    - Progress achieved: Adjustments to conceptual design elements of the housing unit or "nest" were made based upon feedback from Xcel Energy, the Northern Plains UAS Test Site, and UND-RIAS. Airtonomy approved the final design and signed an agreement to create a corresponding prototype.
    - Progress achieved: Northern Valley Machine (NVM) is currently building the Airtonomy housing unit prototype with a delivery ETA of late Q4 2019 to early Q1 2020. Center for Advanced Design (CAD) was contracted to make corresponding modifications to the drone gimbal mount extension.
    - ***Progress achieved: University of North Dakota students finalized design of a housing unit, which Airtonomy approved.***

- Integration of solution
    - Progress achieved: TBD

- Flight tests and report
    - Progress achieved: TBD

- Safety case submission
    - Progress achieved: TBD

Deliverables

Please describe the progress on project deliverables, as stated in your contract, achieved during the reporting period:

- Report on the development, deployment, and testing of the custom drone housing unit.
    - Progress achieved: EA has engaged with ComDel, Northern Valley Machine, and the University of North Dakota regarding hardware design. Microsoft is also being consulted regarding use of FarmBeats. This task will be ongoing through Spring 2020.

- Progress achieved: Conceptual design elements of the housing unit or “nest” were presented to Xcel Energy, Microsoft, and Airtonomy. A corresponding senior design project was initiated with the University of North Dakota.
- Progress achieved: Adjustments to conceptual design elements of the housing unit or “nest” were made based upon feedback from Xcel Energy, the Northern Plains UAS Test Site, and UND-RIAS. Airtonomy approved the final design and signed an agreement to create a corresponding prototype.
- Progress achieved: Northern Valley Machine (NVM) is currently building the Airtonomy housing unit prototype with a delivery ETA of late Q4 2019 to early Q1 2020. Center for Advanced Design (CAD) was contracted to make corresponding modifications to the drone gimbal mount extension.
- ***Progress achieved: University of North Dakota students finalized design of a housing unit, which Airtonomy approved.***

- Report on the development, deployment, and testing of the control software, including the rules based and safety-oriented processes and safeguards.
  - Progress achieved: Development of control system software is ongoing with progress primary attributed to technical architecture required by the FAA as well as continued development of the control system, in particular the drone-based software and corresponding cloud DevOps environment. Software development will be ongoing through Fall 2020.
  - ***Progress achieved: Ongoing development***

- Report on the FAA safety case and simulation.
  - Progress achieved: The Microsoft AirSim simulation, which is pivotal for to the FAA Safety Case, is currently under development. The anticipated completion timeline is Fall 2019. A portion of the simulation work will be displayed within the Fargo Microsoft Innovation Center beginning in October.
  - Progress achieved: Microsoft AirSim simulation development was presented for review by UND-RIAS and Airtonomy. A draft of simulation work to be displayed within the Fargo Microsoft Innovation Center in October has been created.
  - Progress achieved: Final adjustments were made to Microsoft AirSim simulation development based upon feedback. A draft of simulation work was presented on the Fargo Microsoft Campus at 1 Million Cups.
  - Progress achieved: Initial development is now in the hands of UND-RIAS for implementation. Documentation is still being finalized.
  - ***Progress achieved: Airtonomy is working with Xcel Energy and Microsoft to expand simulation to cover a broader selection of power assets.***
  - Progress achieved: Three primary tasks are ongoing. The first is creation of a Technical Architecture in collaboration with corporate partners. This document is in draft format, being reviewed by Xcel Energy, UND-RIAS, and the Northern Plains UAS Test Site. The final version is slated for completion in September 2019. The second task is exploratory work with a corporate partner and Xcel Energy. The objective is to ensure initial system configuration is satisfactory for the FAA Safety Case and Concept of Operations. This work is ongoing with anticipated completion Fall 2019. The last task is determination of required flights of the core Airtonomy solution to be completed on Xcel Energy renewable energy sites. Due to pending

winter weather, these flights will need to occur outside of North Dakota as well. This work will be ongoing through Spring 2020.
    - Progress achieved: The Northern Plains UAS Test Site recommended a three-step sequence to obtain FAA operational waivers.
    - Progress achieved: The Northern Plains UAS Test Site, Xcel Energy, UND-RIAS, and Airtonomy met to discuss and approve the following:
        - Technical Architecture
        - Three-step sequence to obtain FAA operational waivers
        - Creation of initial Safety Case and Concept of Operations by 12/1/19.
        - Scaled testing of Airtonomy solution.
    - Progress achieved: The Northern Plains UAS Test Site, Xcel Energy, UND-RIAS, and Airtonomy are nearing completion of an initial operating waiver for multi-drone, within visual line of sight for submittal to the FAA.
    - ***Progress achieved: On behalf of Airtonomy, the Northern Plains UAS Test Site submitted an operating waiver for multi-drone, within visual line of sight to the FAA for testing on an Xcel Energy site with assistance from UND-RIAS.***

- Report on demonstration to the FAA of the safe deployment of SRA-MDO capabilities to enhance Wildlife Mortality Monitoring and mitigation, Inspection, Maintenance, Safety, and Security aspects of Renewable Energy sites.
    - Progress achieved: TBD

- Report on the obtainment of a permanent FAA waiver for SRA-MDO installation with a given Renewable Energy domain.
    - Progress achieved: TBD

- Report on the commercialization of the SRA-MDO solution, installed on renewable energy sites along with any growth in market share.
    - Progress achieved: TBD

- Report on benefits for North Dakota, such as estimated income potential and jobs created.
    - Progress achieved: TBD

- Report on a cost comparison of traditional methods for monitoring at a wind farm vs. the SRA-MDO.
    - Progress achieved: TBD

Expenditures

Please provide a breakdown of expenditures. Include all sources of match. Provide supporting documentation as a separate attachment.

EXPENDITURES FOR THIS REPORTING PERIOD ONLY				
Project Expense	**NDIC**	**REP Recipient**	**Other Sponsor**	**Total**
Personnel (1 months)		$6,950.00		$6,950.00
Field Equipment				
Travel				
Software Development	$70,080.00			$70,080.00

Other Direct Costs				
Custom Drone Housing Unit Prototype Engineering	$585.00			$585.00
Custom Drone Housing Unit Equipment				
Total	**$70,665.00**	**$6,950.00**		**$77,615.00**

CUMULATIVE EXPENDITURES				
Project Expense	**NDIC**	**REP Recipient**	**Other Sponsor**	**Total**
Personnel (9 months)		$83,400.00		$83,400.00
Field Equipment				
Travel				
Software Development	$293,422.93	$212,394.82		$505,817.75
Other Direct Costs				
Custom Drone Housing Unit Prototype Engineering	$25,548.75			$25,548.75
Custom Drone Housing Unit Equipment				
Total	**$318,971.68**	**$295,794.82**		**$614,766.50**