

Alliance for Sustainable Energy, LLC
operator of the
National Renewable Energy Laboratory

Strategic Partnership Projects
Funds-In Agreement—FIA-22-22344

Appendix A – Statement of Work

Notice: By signing this Agreement, the Sponsor acknowledges in advance that its entity name and the title and non-proprietary description of the project are available for public release by the Contractor without further notice.

I. Project Title: Colorado Alternatively Powered Aircraft Airport Infrastructure Study

II. Non-Proprietary Description of Project:

This study will evaluate new technology and leverage proprietary Transportation Demand Modeling (TDM) tools from the National Renewable Energy Laboratory (NREL), to evaluate where new aircraft technologies might be deployed in Colorado, and identify potential infrastructure, policy and regulatory implications.

III. Parties to this agreement:

Contractor: Alliance for Sustainable Energy, operator of the National Renewable Energy Laboratory under Prime Contract No. DE-AC36-08GO28308 for the U.S. Department of Energy (DOE). Contractor has a facility at 15013 Denver West Parkway, Golden, CO 80401.

Sponsor: State of Colorado, Department of Transportation, State Entity, 2829 West Howard Place, Denver, CO 80204

IV. Background:

Under the direction of the Colorado Aeronautical Board (CAB), the Colorado Department of Transportation's Division of Aeronautics' mission is to support Colorado's multi-modal transportation system by advancing a safe, efficient, and effective statewide aviation system through collaboration, investment, and advocacy.

In the Division's 30-year history, it has developed a legacy and culture of innovation and leadership. The CAB and Division staff take great pride in being on the forefront of aviation and airport technology, safety and efficiency, always looking to the future to leverage new technologies for the benefit of all Coloradans.

At present, a new generation of alternatively powered aircraft are in development worldwide, which will use a variety of new powerplant technologies and airframes that will fundamentally change regional aviation mobility (RAM) and broaden opportunities for general aviation (GA) activities and flight training. While these new aircraft have the potential to create new mobility opportunities and reduce aviation's impact on the environment, they will also pose new infrastructure, policy and regulatory challenges for state and federal aviation agencies, aircraft operators, airports, local utilities, and others.

As a leading state aviation agency, the Colorado Division of Aeronautics is conducting this study to evaluate this new technology and leverage proprietary Transportation Demand

Modeling (TDM) tools from the National Renewable Energy Laboratory (NREL), which is a unique national leader in clean transportation.

With this foundation of TDM, identifying where and how Coloradans travel, the study will then evaluate where these new aircraft technologies might be deployed in Colorado, and identify potential infrastructure, policy and regulatory implications. The intent is to inform planning, development, and funding conversations among stakeholders as this technology matures. The ultimate goal will be to have Colorado's aviation system as prepared as possible to leverage the benefits of these new aircraft technologies when they enter widespread service in the next 10-15 years.

V. Statement of Work - Task Descriptions, Deliverables, and Estimated Completion Dates:
The Contractor will perform the following tasks:

Task 1- Review and summarize existing research and case studies on alternatively powered aircraft (fixed wing, non-eVTOL) and related airport infrastructure needs

1. Leverage existing research as well as present case studies from other entities that are also engaged in analyzing policy-led alternatively powered aircraft adoption. Case studies will capture (as available):
 - a. Goals and objectives
 - b. Benefits, challenges, and risks
 - c. Summary of work-to date
 - d. Identification of proposed actions
 - e. Lessons learned/relevance to Colorado Division of Aeronautics' efforts
 - f. Identification and current Technical Readiness Level of aircraft suitable to Colorado's environment and terrain
2. Known research in progress that will be leveraged includes the National Air and Space Administration (NASA) Langley Regional Air Mobility Study, and potential related Federal Aviation Administration (FAA)/National Renewable Energy Laboratory (NREL) efforts regarding aircraft electrification, as mutually desired.

Deliverable- summary of current research and applicability to Colorado's efforts

Task 2- Quantify the current state and development timeline of alternatively powered regional air mobility and general aviation training aircraft

1. Review of current development status and forecast development/timeline of fixed wing regional air mobility aircraft (4-76 seats) by power type:
 - a. Battery-electric
 - b. Hybrid-electric (hydrogen/fuel cell/jet fuel/etc.)
2. Review of current development status and forecast development/timeline of 2-6 seat general aviation battery-electric flight training/recreational aircraft

Deliverable- summary of current and forecast aircraft developments and likely candidates (by type) for future production/entry into service

Task 3- Study/analysis of Colorado's intrastate travel patterns and demand and identification of Colorado airports likely to support regional air mobility aircraft

1. Coordinate with NASA to accomplish the following:
2. Review/analysis of Colorado's intrastate travel patterns and current demand (provided through existing collaborations with NASA and the Georgia Institute of Technology mid-Atlantic regional travel study)
 - a. By current scheduled air carrier
 - b. By mass transit
 - c. By privately owned vehicle

3. Validate demand modeling with multimodal demand modeling utilizing the NREL proprietary Transportation Demand Modeling tool and other NREL and NASA tools and acquired data sources such as real time, cell-phone derived travel data analysis to facilitate this task.
4. Identification of top 10 publicly owned, public use airports that would serve to support the busiest intrastate regional air mobility routes and associated demand
5. Identification of the Airport Reference Code for those airports and the sizes (and makes/models of aircraft currently in development) of regional air mobility aircraft that could be served by each

Deliverable- summary of key intrastate markets likely to support regional air mobility service, and the airports serving those markets

Task 4- Analysis and identification of Colorado airports likely to support battery-electric GA training aircraft (to be provided by CDOT Aeronautics Division staff)

1. Review/analysis of current significant flight training operations in Colorado
2. Identification of those airports most likely to support broad scale flight training operations with battery-electric GA aircraft
3. Where possible, identify major flight schools (>10 aircraft) with orders or options for battery-electric aircraft, and describe likely fleet introduction timelines
4. Identification of the top five publicly owned public use airports that would most likely support these flight training operations

Deliverable- List of identified airports and related analysis

Task 5. Identify baseline airport infrastructure needs to support alternatively powered aircraft technology at identified airports serving both RAM and general aviation (GA) flight training:

1. Develop a sample of use types/typical energy loads and service conditions, for the identified airports
2. Projected energy demand/needs related to current adoptions rates of new technology including electric aircraft.
3. Fast charging, slow charging, battery storage, fuel cells
 - a. Benefits, challenges, infrastructure requirements, and other considerations
4. Anticipated capacity, loads and storage needs
5. Potential for on-site power generation/storage (solar, etc.)
6. Using NREL proprietary tools, develop projected electrical load curves for typical RAM and GA operations, including analysis of potential benefits of off-peak charging/daytime use
7. Leverage NASA-developed RAM load models to inform this task
8. Charging Infrastructure recommended to simultaneously charge up to three RAM aircraft
9. Facilities needed
10. Projected electricity usage
11. Charging Infrastructure recommended to simultaneously charge up to ten battery electric GA flight training aircraft
12. On-airport charging infrastructure costs
13. Initial cost recovery models for infrastructure

Deliverable- Written summary of baseline infrastructure for identified use cases .

Task 6- For identified airports, develop high level inventory of existing electrical utility service and capacity, and compare to baseline needs developed in tasks 3 and 4. Compare to existing conditions and develop high level per-airport costs to develop projected necessary infrastructure needs and potential funding sources.

1. Utility service upgrade costs to airport
2. On-site photovoltaic generation/energy storage
3. Coordination with energy utility for planning
4. Initial review of existing power quality/availability (sensitive, may be included in limited distribution appendix).

5. Potential funding/revenue generation methodologies
6. Site-level energy optimization evaluation of typical use case categories. Effort will look to optimize cost of energy based upon current rate structures and potential generation/storage opportunities.

Deliverable- Comparison of existing airport conditions to projected need and development of related high level cost estimates

Task 7- Identify at a high level the federal and state policies and funding mechanisms that will need to be evaluated to facilitate the development of this infrastructure.

1. Updates to FAA polices and guidance
 - a. Applicable Advisory Circulars
 - b. Airport Improvement Program (AIP) Handbook/AIP eligibility
2. Federal fuel tax replacement/AIP funding streams
3. State/local fuel tax/airport flowage fee replacement/funding streams
4. Federal/state policies that incentivize electric/hydrogen/sustainable aviation fuel infrastructure

Deliverable- high level summary of federal and state policies and funding mechanisms that will need to be addressed

Task 8- In conjunction with Sponsor, create a study committee to offer input and help review study deliverables.

1. Aircraft manufacturers
2. Identified airports
3. Electric utilities
4. Air carriers
5. Major flight schools
6. Infrastructure (charging/fueling/distribution) manufacturers/supplies
7. FAA
8. Other State of Colorado agencies, such as the Colorado Energy Office

Deliverable- input to support Sponsor in study committee deliverables

Task 9- Report compilation

- Outcomes and deliverables developed under relevant tasks will be compiled into a final report summarizing results.

Deliverables: 1. Preliminary Report for review
2. Final Report

Task 10- Administrative/Project Management

1. Preparation of overall study schedule and deliverable dates
2. Monthly project progress reports
3. Study committee meeting logistics/summary preparation
4. Project tracking against budget

Deliverables: 1. Study Schedule
2. Monthly Project Progress Report,
3. Summary of Study Committee Meetings

Task	Deliverable	Estimated Completion (following Effective Date)
Contractor:		
1	5-6 Page Draft Summary	2 months
2	3-5 Page Draft Summary document	3 months
3	Summary presentation	3 months following receipt of data by NASA
4	To be provided by Sponsor	2 Months
5	Summary presentation	10 months
6	Summary presentation	8 months
7	Summary presentation	12 months
8	Committee support	As needed
9	Draft report	15 months
9	Final report	18 months
10	Schedule, progress report, and notes	Monthly

Note: Deliverable timelines are estimates subject to coordination with

Sponsor and receipt of necessary external inputs within reasonable timelines.

VI. Budget Estimation

CDOT Electrified Aviation Plan NREL Proposal Estimated Breakout

10/7/2022

	Budget Period 1 - FY23	Budget Period 2 - FY24	
a. Fully Burdened Personnel	\$177,274	\$181,977	
c. Travel	\$8,000	\$0	
d. Equipment	\$0	\$0	
e. Supplies	\$0	\$0	
f. Contractual	\$0	\$0	
g. Construction	\$0	\$0	
h. Other	\$8,000	\$8,000	
i. Non-labor Indirect	\$9,709	\$7,040	
Total	\$202,983	\$197,017	<u>\$400,000</u>