DEPARTMENT OF TRANSPORTATION
AERONAUTICS

MINNESOTA ELECTRIC AVIATION NETWORK

M.E.A.N.

STUDY

EXECUTIVE SUMMARY

AUGUST 2025

Courtesy of BETA Technologies

CHARTING THE COURSE

The Minnesota Electric Aviation Network (MEAN) Study, led by the MnDOT Aeronautics office, explores how electric aircraft can be integrated into the state's existing aviation infrastructure. The study responds to the growing momentum behind electric aviation technologies, often collectively referred to as advanced air mobility (AAM), which have the potential to reduce emissions, lower operating costs, increase economic opportunity, and expand access to air transportation across Minnesota.

OBJECTIVE

The MEAN Study identifies a strategic network of Minnesota airports that are best positioned to support electric aircraft operations within the next decade. The study does not prescribe immediate infrastructure investments. Rather, the study establishes a foundational framework to guide meaningful stakeholder engagement, future infrastructure planning, policy development, and investment decisions that advance Minnesota's goals for sustainable aviation.

APPROACH

The MEAN Study adopts a ten-year planning horizon, balancing the urgency of preparing for emerging technologies with the uncertainties surrounding technological maturity, infrastructure funding, and regulatory frameworks. To support this forward-looking approach, the study employs a pragmatic, data-driven methodology that is supported by:

- Extensive stakeholder engagement
- Quantitative and qualitative data collection
- A scoring system to rank airports based on market demand and infrastructure readiness
- A connectivity analysis to ensure a cohesive statewide network

WINGS OF CHANGE: THE RISE OF ELECTRIC AVIATION

Electric aviation is rapidly evolving and growing, driven by technological innovation, environmental imperatives, and growing interest in sustainable transportation. The MEAN Study outlines the current electric aviation landscape through the lens of Minnesota's airport system, highlighting key use cases, technologies, and infrastructure needs.

KEY USE CASES

Electric aircraft are poised to transform several aviation sectors, particularly those involving short-range, high-frequency operations. Minnesota's most promising near-term use cases include:

SHORT-HAUL CARGO

With the rise of e-commerce, electric aircraft can efficiently serve routes under 300 miles, characterized by frequent, time-sensitive deliveries that are essential to logistics networks.

PILOT TRAINING

Electric aircraft offer lower operating costs, reduced maintenance needs, and quieter engines, making them well suited for flight schools and reducing barriers to entry for aspiring pilots.

MEDICAL TRANSPORT

Electric aircraft allow for rapid deployment of personnel, supplies, and patients by eliminating traditional run-up procedures, providing streamlined startup, expedited preflight checks, and quicker launch during emergencies.

INFRASTRUCTURE REQUIREMENTS

To support electric aviation, airports must address several critical infrastructure needs:

CHARGING SYSTEMS

Airports that support electric aircraft require high-capacity DC fast charging systems (300-1,000 kW) to rapidly recharge large batteries between flights.

ELECTRICAL GRID READINESS

Airports need access to three-phase power and sufficient transformer capacity to support electric aircraft charging. Grid upgrades may be necessary to meet peak demand.

THERMAL MANAGEMENT

Cold weather impacts battery performance. Heated hangars, preheating systems, and thermal management strategies are essential in climates like Minnesota's.

FACILITIES AND SAFETY

Airports must provide adequate fire suppression systems, emergency response plans, and crew amenities to support electric aircraft operations.

STAKEHOLDER ENGAGEMENT: A COLLABORATIVE FOUNDATION FOR THE MEAN STUDY

To ensure a comprehensive and inclusive process, the MEAN Study team conducted:

AIRPORT SURVEYS

Distributed to 132 public-use airports and numerous stakeholders to assess infrastructure and interest.

OEM INTERVIEWS

Engaged original equipment manufacturers (OEMs) of electric aircraft, electric and hybrid propulsion systems, and charging infrastructure to understand technical requirements and market readiness.

STAKEHOLDER WORKSHOPS

Facilitated six workshops across Minnesota to gather localized insights and refine evaluation criteria.

UTILITY SURVEYS

Conducted direct outreach to utility providers serving Minnesota airports to inventory site-specific power capacity.

This multi-channel engagement process provided real-world perspectives and technical expertise. Stakeholder input directly influenced the MEAN Study's methodology and findings and informed use case prioritization, evaluation criteria, infrastructure needs assessment, and barriers and opportunities for electric aviation.

MEAN STUDY APPROACH

The MEAN Study employs a pragmatic, system-level approach to identify airports best positioned to support electric aviation within the next decade. The study's methodology is grounded in an analysis of supply and demand, assessing both the potential demand for electric aviation services and the existing infrastructure capacity.

Courtesy of Joby Aviation. © Joby Aero, Inc.

THE MEAN EQUATION

The MEAN Equation guided the evaluation of each public-use airport's potential for electric aviation through a review of Demand and Supply.

Demand + **Supply** = **MEAN**

The business case for electric aviation

Infrastructure readiness for electric aviation

Minnesota Electric Aviation Network

DEMAND ANALYSIS

The demand analysis evaluated Minnesota airports to determine where electric aviation is most likely to succeed. For each airport, the criteria below were scored and weighted based on input from Minnesota airports, OEMs, industry experts, and other stakeholders.

Weight **35%**

Near-term use cases

Focused on pilot training, short-haul cargo, and medical transport.

Weight **15%**

Survey responses

Gauged stakeholder interest and planning efforts for electric aviation and AAM.

Weight **15%**

Regional indicators

Considered population, economic impact, and county EV adoption rates.

Weight **35%**

Airport activity

Assessed flight volumes and route distances under 300 miles.

SUPPLY ANALYSIS

The supply analysis examined each airport's ability to support electric aviation infrastructure.

Weight **60%**

Electrical elements

- Existing electrical capacity
- Availability and location of three-phase power
- Opportunities for utility expansion

Weight **40%**

Aviation elements

- Runway specifications
- Heated hangars
- Emergency response capabilities
- Terminal and crew amenities

Background image courtesy of BETA Technologies

KEY FINDINGS

To identify the MEAN, the project team conducted a comprehensive evaluation that integrated the results of both the demand and supply analyses.[1] Airports that demonstrated strong performance in both areas were considered high-potential candidates for inclusion in the network. Each airport received a composite MEAN score, with demand weighted more heavily to reflect the critical role of viable use cases and economic opportunities in driving early adoption of electric aviation.

To ensure the resulting network was both efficient and geographically balanced, a connectivity analysis was conducted. This analysis evaluated how well candidate airports linked together based on the flight range of a reference electric aircraft. Airports located within 30 miles of one another were reviewed for potential redundancy, and in such cases, the lower-scoring airport was removed from the initial network.

In the Twin Cities metro area, seven airports operated by the Metropolitan Airports Commission (MAC) were consolidated into a single "MAC node" to reflect shared operations and planning efficiencies. This approach helped maximize geographic coverage, minimize redundancy, and strengthen the overall value and cohesion of the MEAN.

After integrating demand and supply scores and conducting a connectivity analysis, the study identified a final network of 27 airports across 21 nodes, listed in **Table 1**. This network:

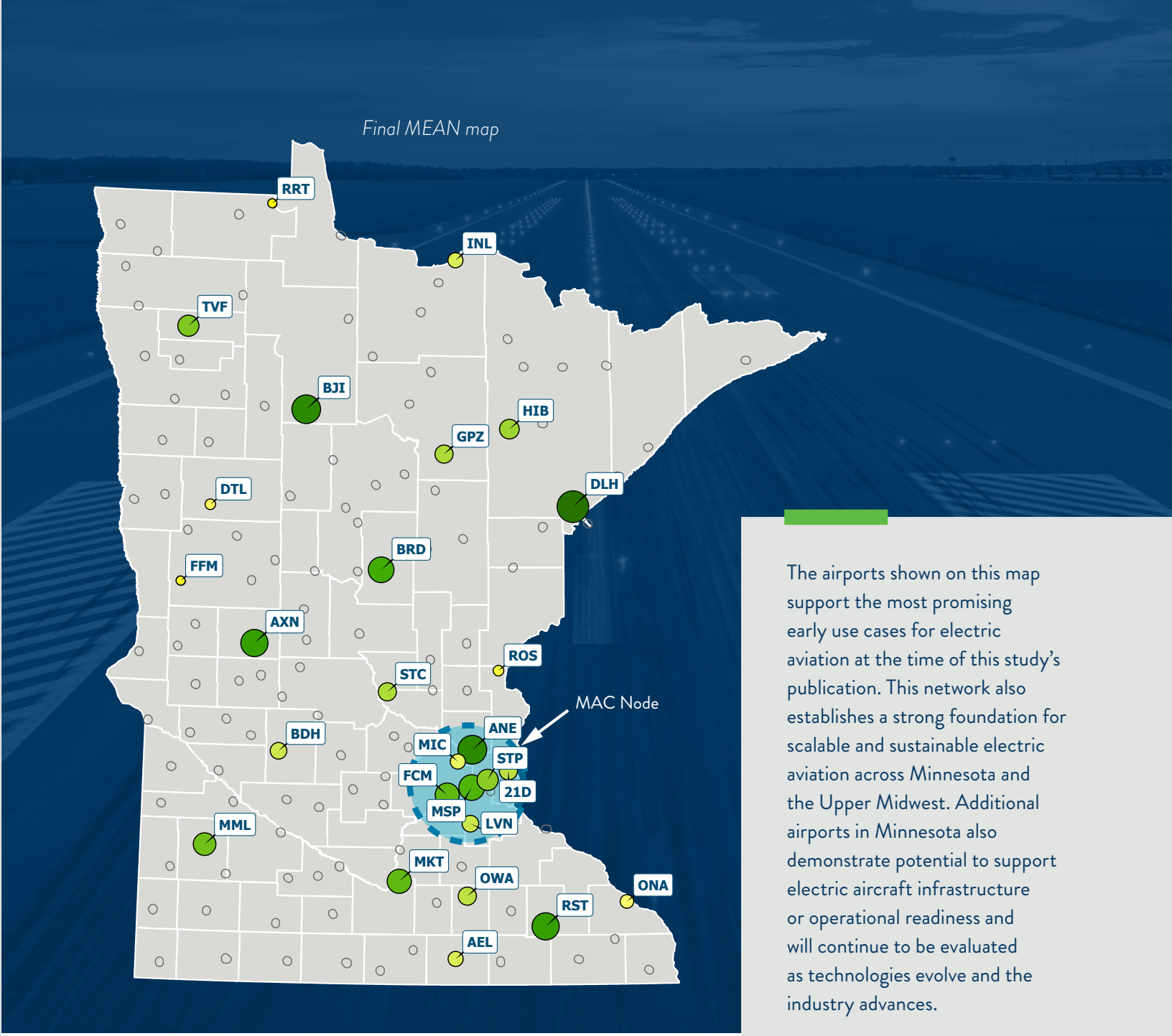
- Ensures statewide geographic coverage, with no node located more than 100 miles from the next closest node.
- Prioritizes strategic placement to maximize route flexibility and economic impact.
- Includes both urban hubs and rural connectors.

Table 1: *Final MEAN airports*

Rank	Score	FAA ID	Airport name
1	9.65	DLH	Duluth International
2	9.15	BJI	Bemidji Regional
3	8.70	ANE	Anoka County/Blaine
4	8.00	AXN	Alexandria Municipal
5	8.00	RST	Rochester International
6	7.90	BRD	Brainerd Lakes Regional
7	7.90	MSP	Minneapolis-St. Paul Int'l
8	7.65	MKT	Mankato Municipal
9	7.60	FCM	Flying Cloud
10	7.40	MML	Marshall-Southwest Minnesota Regional
11	7.40	TVF	Thief River Falls Regional
12	7.35	STP	Saint Paul Downtown
13	7.30	HIB	Range Regional
14	6.95	STC	Saint Cloud Regional
15	6.70	GPZ	Grand Rapids-Itasca County
16	6.00	21D	Lake Elmo
17	6.00	OWA	Owatonna Degner Regional
18	5.95	LVN	Airlake
19	5.90	BDH	Willmar Municipal
20	5.80	INL	Falls International
21	5.80	AEL	Albert Lea Municipal
22	5.70	MIC	Crystal
23	5.55	ONA	Winona Municipal
24	5.40	DTL	Detroit Lakes
25	5.25	ROS	Rush City Municipal
26	5.05	FFM	Fergus Falls Municipal
27	4.80	RRT	Warroad International

MAC node airports

[1] *Scoring was based on confirmed data or, where unavailable, informed assumptions using aerial imagery and site characteristics.*



The airports shown on this map support the most promising early use cases for electric aviation at the time of this study's publication. This network also establishes a strong foundation for scalable and sustainable electric aviation across Minnesota and the Upper Midwest. Additional airports in Minnesota also demonstrate potential to support electric aircraft infrastructure or operational readiness and will continue to be evaluated as technologies evolve and the industry advances.

POSITIONED FOR THE FUTURE

Looking ahead, the MEAN Study is designed to serve as a flexible planning resource rather than a prescriptive policy or funding directive. Airport sponsors, planners, businesses, and OEMs can use this study to help assess readiness, identify infrastructure needs, and explore opportunities for integrating electric aviation. The study provides actionable insights supported by clear methodology to support informed, community-driven decision making when the time is right In doing so, it positions Minnesota to prepare thoughtfully and strategically for a future in which electric aviation becomes a meaningful and transformative component of the state's transportation system.

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