RESEARCH

UDOT Keeping Utah Moving

Utah Department of Transportation - Research Division
4501 South 2700 West - P.O. Box 148410 - SLC,UT 84114-8410

Report No. UT-22.12

ELECTRIFICATION PLAN FOR STATE OF UTAH AIRPORT INFRASTRUCTURE

Prepared For:

Utah Department of Transportation
Research & Innovation Division

Final Report
July 2022

DISCLAIMER

The authors alone are responsible for the preparation and accuracy of the information, data, analysis, discussions, recommendations, and conclusions presented herein. The contents do not necessarily reflect the views, opinions, endorsements, or policies of the Utah Department of Transportation or the U.S. Department of Transportation. The Utah Department of Transportation makes no representation or warranty of any kind, and assumes no liability therefore.

ACKNOWLEDGMENTS

The authors acknowledge the Utah Department of Transportation (UDOT) for funding this research, and the following individuals from UDOT on the Technical Advisory Committee for helping to guide the research:

- Project Champion
  - Jared Esselman: UDOT, Director of Aeronautics
- Project Manager
  - Robert Chamberlin: UDOT (consultant), PE/PTOE
- Technical Advisory Committee
  - Steven Ley: UVU, Associate Professor
  - John Salmon: BYU, Assistant Professor
  - Craig Ide: UDOT, Division of Aeronautics
  - Paul Damron: UDOT, Division of Aeronautics

TECHNICAL REPORT ABSTRACT

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UT- 22.12	N/A	N/A

4. Title and Subtitle Electrification Plan for State of Utah Airport Infrastructure	5. Report Date July 2022 6. Performing Organization Code TBD
7. Author(s) EPS: Carsten Christensen, Dr. David Christensen, Dallin Dahl, Steven Hall, David Koch, Thomas Payne ASPIRE: Kamie Champlain, Hossein Nasr Esfahani, Jackson Morgan, Dr. Ziqi Song, Dr. Regan Zane	8. Performing Organization Report No. TBD
9. Performing Organization Name and Address Electric Power Systems, Inc. 520 W 2850 N North Logan, UT 84341 ASPIRE, Utah State University 9805 Old Main Hill Logan, UT 84322 Physical Address 620 E 1550 N North Logan, UT 84341	10. Work Unit No. 5H086 63H 11. Contract or Grant No. 228185
12. Sponsoring Agency Name and Address Utah Department of Transportation 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410	13. Type of Report & Period Covered Final Nov. 2021 to July 2022 14. Sponsoring Agency Code PIC No. 21.0505

15. Supplementary Notes
Prepared in cooperation with the Utah Department of Transportation

16. Abstract

A framework is described to aid government and private entities in exploring the impacts of electrified aviation technology on the aviation ecosystem and to plan grid and charging infrastructure development at airports in preparation to support electrified aviation. Exploratory analyses are conducted to forecast the deployment and adoption of electric aircraft in support of flight school, thin haul/commercial, and advanced air mobility operations. Requirements to adapt electrical grid capability and develop aircraft charging infrastructure at and around airports are defined and substantiated together with a use case examining the cost of deploying fixed and mobile charging assets at airports with or without alternative energy generation methods.

17. Key Words	18. Distribution Statement	23. Registrant's Seal
Electric Aviation, Electric Vehicles, Battery Systems, Charging Infrastructure, Electrical Grid, Decision-Making Framework	Not restricted. Available through: UDOT Research Division 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410 www.udot.utah.gov/go/research	N/A

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	130	N/A

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

UNIT CONVERSION FACTORS

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. (Adapted from FHWA report template, Revised March 2003)

LIST OF ACRONYMS

AA	Alpine Air (aviation company)
AADT	Annual Average Daily Traffic
AAM	Advanced Air Mobility
AMP	Aviation Maintenance Professional
ASPIRE	Advancing Sustainability through Powered Infrastructure for Roadway Electrification
BESS	Battery Energy Storage System
DoD	Depth of Discharge
EPS	Electric Power Systems, Inc.
EV	Electric Vehicle
EVSE	Electric Vehicle Service Equipment
EVTOL	Electrical Vertical Takeoff and Landing
ICE	Internal Combustion Engine
IFR	Instrument Flight Reference
kW	kilowatt
kWh	kilowatt-hour
nm	Nautical Mile
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance
PV	Photovoltaic (i.e., solar power)
RMP	Rocky Mountain Power
SUU	Southern Utah University
TCO	Total Cost of Ownership
UDOT	Utah Department of Transportation
USU	Utah State University
UTRAC	Utah Transportation Research Advisory Council
UVU	Utah Valley University
U-SWEAP	Utah Statewide Electrified Aviation Plan (Framework)
VFR	Visual Flight Reference

EXECUTIVE SUMMARY

The advent and proliferation of electrified aviation technology and operations is imminent. The state of Utah recognizes the potential advantages of preemptively exploring and planning for a future in which its airports and transportation ecosystem will both need to adapt to new modes of aviation operation and have the opportunity to evolve and thrive through that adaptation. To that end, this work provides an exploration forecasting the development of electrified operations in flight school, thin haul/commercial, and AAM segments in the state's aviation ecosystem. It uses those forecasts to accomplish the following:

- Generate analyses to derive requirements for grid capability at airports
- Explore how grid and charging infrastructure could be adapted to meet those requirements
- Define the research activities required to understand the impact of electrifying aviation on the statewide aviation ecosystem

The scope of this work encompasses forecasting, analysis, and synthesis activities divided into six research tasks. These research tasks address the following topics:

1. Flight School Operations Electrification Forecast
2. Thin-Haul/Commercial Operations Electrification Forecast
3. Advanced Air Mobility (AAM) Introduction and Electrification Forecast
4. Electrified Aviation Energy and Power Requirements
5. Proposed Approach for Deploying Electric Aviation Support Infrastructure
6. Utah Statewide Electrified Aviation Plan (U-SWEAP) Framework

The forecast data from Tasks 1-3 are synthesized to derive the requirements and approach proposed in Tasks 4 and 5, while data and analyses from each of Tasks 1-5 is used to develop and support the framework developed in Task 6.

The U-SWEAP Framework and supporting research presented in this work are intended to guide UDOT and the state of Utah's approach to preparing for, facilitating, and thriving because of the advent and proliferation of electrified aviation. The U-SWEAP framework and its described outcomes provide a vision and vehicle through which the economic, behavioral, and material impacts of electrified aviation on other segments in its ecosystem may be explored and quantified.

The exploratory work completed in forecasting the electrification of flight school, thin haul/commercial, and AAM operations in the state provides a unique and detailed view into the requirements, challenges, and opportunities presented by electrified aviation technology. Specifically, these investigations illuminate the timelines over which electric aircraft and infrastructure may become available, the volumes in which they may be deployed, and the requirements they will leverage on existing air traffic management and electrical grid infrastructure. Preeminent among those requirements, this work explores the new demands that electrified aircraft operations will leverage on the electrical grid at and around airports in both urban and rural settings and provides an example of how fixed- and mobile-asset charging infrastructure could be functionally and financially implemented at a major airport.

1.0 INTRODUCTION

1.1 Problem Statement

Recent advancements in electric aircraft technology are now and will continue to come to market in increasing volume and variety and are poised to revolutionize transport of people and goods. Potential equipment and operational cost savings of electrically powered aircraft suggest and enable uses of aviation corridors and infrastructure in unprecedented volumes. Strategic and proactive preparation by the Utah Department of Transportation (UDOT) for this new technology ecosystem will help the state lead sector development and be able to benefit from the projected economic and social benefits this emerging industry will bring.

Electric aircraft require different infrastructure than current airports, and utilities are designed to accommodate, particularly for energy generation, storage and distribution equipment. The imminent ubiquity of electric aircraft technology, however, will manifest over time and can be successfully prepared for through coordinated, optimized, deliberate planning. This planning effort must begin with an understanding of which sectors of aviation may become first-adopters of electrified aircraft technology. This study examines the potential for electrification within each of the following industry segments following a phased approach:

- Phase 1 of Aviation Electrification: Flight School Operation
- Phase 2 of Aviation Electrification: Thin-Haul/Commercial Operation
- Phase 3 of Aviation Electrification: Advanced Air Mobility (AAM) Operation

Phase 1 of aviation electrification in Utah has already begun. Flight schools across Utah are working to adopt electric training aircraft as soon as they become available, an initiative that necessitates the immediate requirement to study and design a comprehensive plan for electrification of airport infrastructure to accommodate future needs. Phase 2 is also of developing interest, with major carriers like United Airlines contracting with developers like Heart Aerospace to purchase large, electrified aircraft for thin-haul operations.[29] Where electrified aircraft technology becomes a common, if not still novel, part of daily life with the advent of air taxi services in inter- and intra-city contexts (Phase 3), a concept that has long generated public hype and interest and for which the enabling technology is beginning to mature.[16,18,23] Sections 2.2.1, 2.3.1, and 2.4.1 each explore in further detail the technological and economic potential for each of the three market segments explored in this report and rationalize their consideration as primary areas of opportunity for electrification.

In order to support the proliferation of electrified aviation operations across the state and Intermountain region, significant capital investment will be required to develop the charging and energy infrastructure that support electric fleets. The state of Utah needs visibility into the larger ecosystem in which electrified aviation will exist and the relationships between the emerging and established entities and technologies within that ecosystem, including the economic drivers and effects of aviation electrification. With a solid understanding of the impact of electrified aircraft technology and operations on this ecosystem, the state will be equipped to make informed decisions in supporting and facilitating the various business models for developing and commercializing the technological, social, and economic infrastructure that will enable the economic and social growth and opportunities brought on by the state's aviation renaissance.

1.2 Objectives

This project is intended to complete six major research tasks in the pursuit of creating a framework to inform the development of electrified aviation in Utah—the Utah Statewide Electrified Aviation Plan, or U-SWEAP.

The six research tasks are:

1. Development of an electrification forecast for flight school operations in Utah (Figure 1)
2. Development of an electrification forecast for thin-haul/commercial* operations in Utah (Figure 1)**
3. Development of an electrification forecast for AAM operations in Utah (Figure 1)**
4. Electrified Aviation Energy and Power Requirements: Derivation of power and energy requirements at the Utah airports that could support electrified aviation operations
5. Proposed Approach for Deploying Electric Aviation Support Infrastructure: Exploration of the costs associated with approaches for developing electrified aviation infrastructure

6. U-SWEAP Framework: An exploration of the relationships between electrified aviation technology and the ecosystem in which it operates and models that may be used to define and analyze those relationships and that ecosystem***

**Note: Thin-haul/commercial operations generally include small capacity (e.g., 8-20 passengers or small cargo loads) point-to-point flights between regional or inner-state airports (e.g., daily mail carrier flights between Salt Lake City and St. George), and are typically less than 200 nautical miles long*

***Note: The findings of each forecast in Tasks 1-3 are synthesized into a statewide aviation electrification forecast that examines the ramifications of their collective impact on the larger aviation ecosystem.*

****Note: These relationships and models are explored as part of the report's framework outline.*

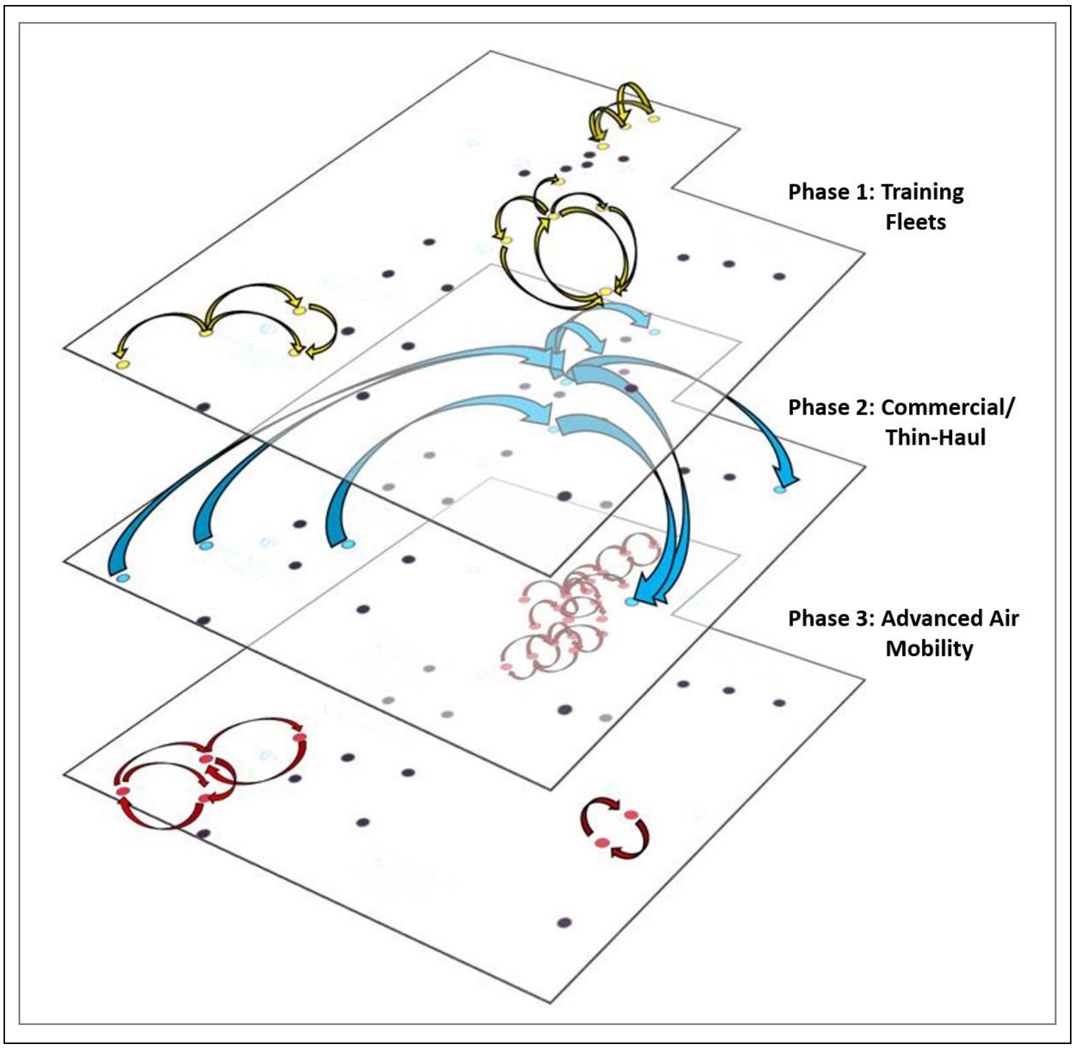

Figure 1. Three phases of aviation electrification in Utah

The U-SWEAP framework is the primary deliverable for this work and is intended to provide an outline of the relationships between electrified aviation technology and the grid, economic, transportation, environmental, and social ecosystem segments that it influences or by which it is influenced. By combining information and analytical tools developed in forecasting the three phases of aviation electrification in the state, the U-SWEAP framework provides a means by which stakeholders may estimate the following critical information:

- The airports that could be prioritized for charging infrastructure and grid infrastructure development
- The amount and capability of charging infrastructure potentially required at each airport
- The potential economic costs and returns of airport electrification
- The potential economic impact of state-owned versus industry-owned infrastructure development models
- The potential emissions costs and returns of airport and fleet electrification

1.3 Scope

The scope for each of the six research tasks is outlined below.

1. Development of an electrification forecast for flight school operations in Utah
    - Collaboration with the three largest university-operated flight schools in Utah (UVU, USU, SUU) to explore fleet electrification timelines, opportunities, and limitations
    - Create a potential timeline and electric aircraft adoption schedule for each flight school
    - Define a method for estimating the energy and power requirements for each flight school's projected electrified fleet
    - Estimate the representative energy and power requirements for each flight school's projected electrified fleet
2. Development of an electrification forecast for thin-haul/commercial operations in Utah

- Research existing Utah-centered thin-haul/commercial operations to identify candidate routes and volumes for electrification
- Create a potential timeline and electric aircraft adoption schedule for a sample of the researched thin-haul/commercial operations
- Define a method for estimating the energy and power requirements for a potential thin-haul/commercial electrified fleet
- Estimate the representative energy and power requirements for a representative thin-haul/commercial electrified fleet

3. Development of an electrification forecast for AAM operations in Utah

    - Research developing AAM aircraft and their potential operating parameters
    - Identify possible hubs and routes for AAM operations
    - Create a potential timeline and deployment schedule for a representative AAM fleet and its operations
    - Define a method for estimating the energy and power requirements for a potential AAM fleet and its operations
    - Estimate the representative energy and power requirements for the representative AAM fleet and its operations

    FORECAST SYNTHESIS: compile information from the forecasts for the three phases to generate a statewide aviation electrification forecast, and estimate aviation power and energy demands at the state's airports

4. Electrified Aviation Energy and Power Requirements: Derivation of new power and energy requirements at the Utah airports that are projected to support electrified aviation operations

    - Identify the energy/power-providing capability at Utah airports identified as candidates for supporting electrified aviation
    - Observe requirements for future infrastructure developments to support projected aviation electricity demand at relevant airports

5. Proposed Approach for Deploying Electric Aviation Support Infrastructure: Exploration of the costs associated with different approaches for deploying and operating electrified aviation supporting infrastructure

- Explore and define options for fixed- and mobile-asset electric aviation support infrastructure at airports
- Quantify the relative cost to install and operate the defined infrastructure options
- Analyze the utility and propose applications for the defined infrastructure options

6. U-SWEAP Framework: An exploration of the relationships between electrified aviation technology and the ecosystem in which it operates and models that may be used to define and analyze those relationships and that ecosystem

    - Identify the data-gathering activities, analyses, and analysis outputs associated with forecasting the proliferation of electrified aviation technology in the state
    - Identify the principal grid, economic, transportation, environmental, and social environmental ecosystem segments that could be affected by the proliferation of electrified aviation technology
    - Identify the data-gathering activities, analyses, and analysis outputs associated with exploring the effects of electrified aviation technology on the identified ecosystem segments
    - Identify the relationships between electrified aviation technology deployment and the identified ecosystem segments
    - Represent the electrified aviation ecosystem and the identified data-gathering activities, analyses, and analysis outputs together with the inner-ecosystem relationships as the U-SWEAP framework
    - Identify potential outcomes from exercising the U-SWEAP framework, including potential considerations in developing business cases centered on electrified aviation technology and techno-economic synergies within the ecosystem

1.4 Outline of Report

The report is composed of the following sections:

1. **Introduction**: An overview of the project's problem statement, objectives, scope, and the report's organization

2. **Research Methods**: An overview of the background, assumptions, methods, and results associated with each of the six research activities that represent this work. Each method is presented as a sub-section and addresses the background, assumptions, methods, and results for each research task. The tasks are presented in this manner due to their sequential relationship: Task 1, Task 2, Task 3 and their compiled information allow for the completion of Task 4, which in turn enables the analysis and exploration in Task 5. The sum work completed in all tasks informs the U-SWEAP framework developed in Task 6.

3. **Conclusions**: A summary of the findings from the completion of each research task

4. **Recommendations and Implementation**: An outline of the activities that the authors recommend be conducted to capitalize on the information created in this work and the authors recommendations for deployment of the U-SWEAP framework

5. **References**: Works used to support and substantiate the U-SWEAP framework and its development

6. **Appendices**: Data and other information created during the project that cannot be reasonably presented in the main body of the report

2.0 RESEARCH METHODS

2.1 Overview

This section provides detailed descriptions of the background, assumptions, methods, and results associated with each of the six research tasks identified in the objectives and scope for this work. Each method is presented as a sub-section and addresses the background, assumptions, methods, and results for each research task. The tasks are presented in this manner due to their sequential relationship: Task 1, Task 2, Task 3 and their compiled information allow for the completion of Task 4, which in turn enables the analysis and exploration in Task 5. The sum of work completed in all tasks informs the U-SWEAP framework developed in Task 6.

2.2 Research Task 1: Flight School Operations Electrification Forecast

2.2.1 Research Task 1: Background and Assumptions

Electric vehicles utilize rechargeable lithium-ion batteries as the alternative fuel source to traditional fossil fuels used in internal combustion engines (ICE). The distance a vehicle can travel between refueling, defined as a vehicle's "range," depends on the fuel consumption rate and the size of the fuel tank. Consequently, the more fuel an aircraft can carry the greater distance it can travel between refueling. With electric aircraft this same principle applies as the range of an electric aircraft depends upon the consumption rate of the battery's energy and the overall size of the installed battery system.

Similar to the automotive industry, aircraft manufacturers developing electrified aircraft can either develop an entirely new aircraft or modify an existing airframe to incorporate electric propulsion technology. The industry is experiencing significant growth in legacy companies and startups designing new electric aircraft. We also observe many manufacturers with plans to leverage existing airframes already in production and modify them to incorporate electric technology. A principal challenge with any new EV platform is that current lithium-ion battery technology has a lower gravimetric energy density compared to fossil fuels such as Avgas. Most electric aircraft in development have a reduced range compared to an equivalent ICE counterpart.

The realistic range for an all-electric aircraft installed with current commercially available battery technology equates to roughly 1-2 hours of flight time. Original equipment manufacturers (OEMs) are looking for aviation markets that can perform their intended flight profiles given this flight time constraint. These use cases are ideal segments for introduction of electrification as they can perform the useful mission while receiving the advantages of electrification such as decreased maintenance and operation costs, or improved environmental benefits with decreased noise or emissions. This market segment also needs to be large enough for a given business to recoup the high design and certification costs required to introduce a new product to the market.

Flight schools have been identified as a key target market for electrification adoption given the ability for this segment to utilize an aircraft that has reduced range capabilities. The average flight time across a flight school's fleet ranges between one and two hours. While some longer flights (e.g., cross-country) will exceed the range of a small electric aircraft, most one-hour flights can be successfully accomplished with an electric aircraft's more limited range. Thus, flight schools are likely to see minimal impact to existing operations and receive the cost and environmental benefits of adopting electric aircraft.

Flight schools often use two- or four-seat aircraft as the primary equipment for training pilots. Common aircraft that are used in flight training include the Diamond DA40, Cessna 172, Piper Archer, and the Cirrus SR20. Researching the market for electric aircraft concepts that will be available, two of the most credible development projects include Diamond Aircraft converting its popular DA40 airframe to an all-electric variant named the eDA40. A second notable project is a completely new aircraft design from Bye Aerospace named the eFlyer2.[1,2,3,4]

Training schools will also need to develop the curriculum for pilots to fly electric aircraft concepts for commercial and electrified-vertical-takeoff-and-landing (EVTOL) aircraft. As indicated by the forecasts developed in this section and based on interviews with flight school leadership, Utah's flight schools intend to pursue a policy of rapid electrification.

2.2.2 Research Task 1: Data Summary

The three largest flight schools in the state of Utah include Utah State University (USU), Utah Valley University (UVU), and Southern Utah University (SUU) which are all state-owned schools. Both USU and UVU are already invested in the Diamond DA40 platform operating over 35 DA40[5] aircraft between the two schools. Given that these are state-owned schools, the state of Utah has thus invested in this platform which makes an eDA40 a probable candidate for selection. This aircraft will likely be one of the first electric aircraft certified and introduced to the market shortlisting the potential options if the state would like to be a leader in this space. The schools additionally have training and maintenance programs established around the platform where an electric variant would align well strategically for these entities.

This report has determined to use the eDA40 specifications as the baseline for aircraft specifications in this model and analysis as it is a likely candidate for introduction into the state of Utah. The purpose of this report however is not to identify the exact aircraft that will be adopted but to analyze the likely impact and requirements needed. Whether it is the eDA40 or eFlyer2 or another aircraft concept that is ultimately adopted, the aircraft battery size and specifications will be within the boundaries of this research and model. As training schools will adopt a small two- to four-passenger electric aircraft, the energy requirements will be similar across platforms between 70-100 kWh.

During this study, market research data was gathered from the above mentioned three flight schools through a series of interviews. In each interview, EPS representatives and flight school leadership explored how electrification could or would be adopted into each of the school's operations. This market research for each school included analysis on aircraft information, airframe utilization, operating costs, training courses, flight operation, strategic objectives, and perceived risks. From these interviews the background data was identified along with the potential and likely adoption forecasts for each school collaboratively defined found in

Airport Location	Airport Code	Airport Location	Airport Code
Parowan, UT	1L9	Pocatello, ID	PIH
Billings, MT	BIL	No Airport, UT	Park City*
Brigham City, UT	BMC	Phoenix, AZ	PHX
Bountiful (Skypark), UT	BTF	Price, UT	PUC

Cedar City, UT	CDC	Provo, UT	PVU
Moab, UT	CNY	Rock Springs, WY	RKS
Denver, CO	DEN	Rexburg, ID	RXE
Elko, NV	EKO	St. George, UT	SGU
ELY, NV	ELY	Salt Lake International, UT	SLC
Wendover, UT	ENV	Spanish Fork, UT	SPK
Heber City, UT	HCR	Twin Falls, ID	TWF
Idaho Falls, ID	IDA	No Existing Airport, UT	Thanksgiving Point*
Jackson, WY	JAC	No Existing Airport, UT	The Point*
Hailey, ID	KSUN	West Jordan (South Valley), UT	U42
Las Vegas, NV	KLAS	Vernal, UT	VEL
Logan, UT	LGU	Winnemucca, NV	WMC
Nephi, UT	NPH		

Table 12.

2.2.3 Research Task 1: Forecast Development Methodology

2.2.3.1 Energy Forecast

The amount of energy consumed per flight is based on the estimated battery system size and depth of discharge (DoD) per flight. The three state flight schools align with the national flight school average flight time of 1-2 hours. Diamond Aircraft has published that the eDA40 will be capable of a 90-minute flight time with a 20-minute recharge time[2]. Factoring in required Visual Flight Reference (VFR) reserves we forecast each flight will consume around 60 kilowatt hours of energy. To replenish this amount of energy in 20 minutes would require a charge rate of greater than 180 kilowatts.

Future work to refine this model could incorporate dynamic aircraft mission profiles to develop distributions of energy consumption and flight times.

2.2.3.2 Daily Flights

The number of daily flights forecasted is derived from flight school interviews and looking at historical flight data. Four daily flights estimates consider an 8-hour operation where the aircraft can fly for 90 minutes with 30 minutes of charge and changeover between flights.

Future modeling can incorporate seasonality analysis to determine daily flights based on weather patterns and operating daylight hours.

2.2.3.3 Aircraft Volume

The volume of aircraft adoption is based on specific course adoption and flight operation planning that will leverage electric aircraft. The flight schools identified a specific course and aircraft needed to support the class cohort size. For illustration purposes, an initial private pilot course of 30-50 students may require 4-5 electric aircraft.

The volumes of the time period progress adding additional courses and supporting aircraft. This forecast also factors aircraft battery energy density increasing in the later period where additional courses and flight times can be successfully completed with improved electric aircraft.

This forecast also observed funding requirements and equipment refresh schedules for each school. Where USU and UVU already have supporting maintenance operations to adopt a DA40 fleet, a faster adoption curve is forecasted. Where SUU would require a mixed fleet, this adoption forecast would be more conservative as operational constraints will need to be overcome. Two separate forecasts are observed for SUU depending on these auxiliary constraints.

2.2.3.4 Charging Locations

Most flight training operations occur in the vicinity of each of the school's home-base airport operations. Thus, most of the charging requirements would occur at the airports of Logan-Cache, Provo, and Cedar City. Where alternate airport charging may be required is when the aircraft range is not sufficient to complete the required training within the vicinity of the airport. For example, during cross-country training a pilot will be required to fly extended distances that an initial electric aircraft cannot support. Operational planning may have to be altered to require a mid-flight landing at a satellite airport to recharge prior to completing the full flight plan. Working with each school this analysis forecasts specific instances and satellite airports that may require charging infrastructure in order to meet training needs.

With the defined adoption forecast and factoring in published data on the eDA40 platform we were able to model the impact and requirements at airports to be able to fully support the school requirements.

2.2.4 Research Task 1: Preliminary Analysis and Results

The contribution of electrified flight school operations along the Wasatch Front to the statewide electrification forecast is one of the most significant drivers to overall energy demand and needed support infrastructure. Flight schools will likely be the first adopters of electric aircraft. Given the high-volume training performed in the state of Utah, these demands for the schools expect to create electric infrastructure hubs at the Logan, Provo, and Cedar City airports. This infrastructure will be a key enabler to support future segments in thin haul and AAM that has a longer time horizon for entry into the market.

2.3 Research Task 2: Thin-Haul/Commercial Operations Electrification Forecast

2.3.1 Research Task 2: Background and Assumptions

A thin-haul route is a point-to-point route typically 200 nautical miles or less. These types of routes have been largely abandoned by commercial-volume airline operators because of costly operations serving smaller markets with the large commercial aircraft used today. These routes are largely served by boutique commuter airlines today. Example airlines serving these types of routes include Cape Air, Kenmore Air, Surf Air, and other similar airlines.

Many feasibility studies have been performed on the viability of thin-haul commercial routes. These studies have investigated aircraft and airline operations to analyze economic and technical feasibility for these routes[6]. An important study performed on behalf of the state of Utah is the Balance Utah Feasibility Study analyzing a Vernal to Salt Lake City and/or Provo route[7]. This report presents a succinct summary of the variables for consideration in commercializing underserved thin-haul routes. Additionally, the study highlights the constraints preventing these routes from becoming economically viable.

Many new studies[8] are beginning to research how electrification concepts influence the baseline assumptions and potentially revive these routes as high-volume passenger carrying routes. Electrification has the potential to overcome many of the operational constraints as aircraft can obtain lower operating and maintenance costs. As the operational cost to serve these routes can be reduced, these routes become viable with increased demand from lower ticket prices.

2.3.2 Research Task 2: Data Summary

2.3.2.1 Aircraft Specifications

Thin-haul routes will require electric aircraft that have a high useful payload for cargo or passengers while also being capable of a range of roughly 200 nautical miles or more. Market research identified many hybrid aircraft designs in addition to all-electric designs being pursued to fulfill this need[9]. Many industry companies are targeting aircraft sized for 19 passengers or fewer to fall within the regulatory Part 23 class of aircraft for certification purposes. The data used in this model selected three likely configurations based on all-electric aircraft and hybrid configurations that would allow for the required range.

Tecnam Aircraft has published data for an all-electric version of its P2012 Traveler named the P-Volt[10]. Tecnam is working to develop and bring this aircraft to market that will have a max range of 85 nautical miles, not including reserves, with initial entry into service. The manufacturer estimates this range increases to 145 nm by 2030 as battery energy density increases. The P-Volt will be a 9 to 11 passenger aircraft planned for thin-haul routes or could be configured for cargo operations or as a special mission aircraft.

To analyze thin-haul-capable electric aircraft with ranges above 85 nautical miles, this report pulled from research conducted by EPS (summarized in the following paragraphs) modeling aircraft for hybrid and all-electric configurations. The approach taken by EPS compiled existing aircraft specifications and generated a model for estimating range and capabilities of electric variants for each of these airframes. Two common airframes that are widely used in existing thin-haul routes today include the single engine Cessna Caravan and the dual engine Beechcraft

King Air. Multiple companies in industry are pursuing airframes similar to these as potential electrification candidates.

EPS's hybridization model on the Caravan observed many battery system sizes depending on mission and range requirements. To reduce offsetting passenger seats and retain 10 seats while also maximizing the range, EPS concluded that a roughly 40 kWh battery in a hybrid configuration could be a likely solution. In this configuration, we estimate this type of aircraft could have a range over 300 nm compared to less than 85 nm for an all-electric variant.

Modeling the larger dual-engine King Air aircraft generated an output of an 11-seat configuration with over 300 nm. This aircraft, however, would require increased battery energy density and wouldn't likely be able to be introduced to the market until the latter end of the time-period analyzed. We estimate this size aircraft would need around 300 kilowatt hours of installed energy to meet the mission requirements.

While this report uses the three above-mentioned aircraft, the purpose of this study is not to define the exact electric aircraft makes and models that will be first to market. The aircraft modeled in the analysis were chosen based on the current state of the industry, and the actual first-to-market aircraft may differ. Notwithstanding the uncertainty in exact aircraft make and model, the battery sizes and energy requirements forecast here are highly likely for the first aircraft introduced in the time period for thin-haul operations[11].

2.3.2.2 Route Data

Thin-haul route data within the state of Utah was collected from existing routes as well as projected potential routes. Flight Aware[12] data for a 90-day period was compiled for both a cargo operator and passenger airliners to identify potential routes that could be likely candidates serviced by electric aircraft. Additional ticketing websites were reviewed for passenger routes currently being serviced.

Alpine Air (AA) is a large-cargo regional-contract airline that has mail contracts with USPS and UPS. Alpine Air serves many cargo routes throughout the state of Utah which are identified as "logistic routes" in this report. Flight data identified typical AA flights departing Salt Lake International Airport in the morning with a final return in the evening. The aircraft typically only service one route per day with the full daily route data detailed in Table 1.

Table 1. Existing Alpine Aviation Routes in Utah (Dec. 2021-Feb. 2022).[12] See Appendix A for airport acronym list.

Alpine Aviation Daily Routes							
Origin	Dest	nm	Flights/day	Origin	Dest	nm	Flights/day
SLC	IDA	164	1	SLC	PIH	128	1
IDA	SLC	164		PIH	SLC	128	
SLC	RXE	194	1	SLC	WMC	265	1
RXE	SLC	194		WMC	ELY	167	
SLC	CDC	192	1	ELY	SLC	160	
CDC	SGU	44		SLC	TWF	152	1
SGU	SLC	236		TWF	SUN	62	
KSLC	KSUN	193	1	SUN	TWF	62	
KSUN	PIH	83		TWF	SLC	152	
PIH	SLC	130		SLC	EKO	174	1
SLC	VEL	116	1	EKO	SLC	174	
VEL	PUC	74		SLC	BIL	337	1
PUC	SLC	91		BIL	SLC	337	
SLC	RKS	141	1	SLC	JAC	178	2
RKS	SLC	141		JAC	SLC	178	

SkyWest Airlines is a regional airline headquartered in Southern Utah. SkyWest services routes for partner airlines such as Delta Airlines, United Airlines, and American Airlines. Flight data for SkyWest routes less than 300 nautical miles departing or arriving at a Utah airport was collected. Passenger charter routes were also collected over the 90-day period. These existing routes formed the initial data for potential thin-haul passenger routes.

The team finally forecasted new thin-haul routes that could connect the state in a network model[13] with north and south routes as well as east and west routes. These routes were determined based on major population centers, current commuter routes and ground traffic patterns, airport locations, and tourist destinations.

2.3.3 Research Task 2: Forecast Development Methodology

2.3.3.1 Energy Forecast

For each aircraft, an energy consumption factor was determined based on battery size and max range. This factor provided a control to calculate the energy in kilowatt hours consumed for every nautical mile traveled. The total amount of energy consumed per flight then was based on the distance of the route multiplied by the energy consumption factor. This energy consumed is the “Recharge kWh” in Table 14 that would have to be replenished.

For the logistic routes, historical data shows these cargo aircraft depart from Salt Lake City in the morning and deliver its cargo. The aircraft then remain idle for most of the day until the new evening cargo is loaded, and the aircraft returns to the SLC hub for additional distribution. The operating mode of these aircraft with only one round-trip flight per day with significant downtime between legs allows for adequate time to recharge the electric aircraft. These aircraft do not require fast charging and quick turnaround as they can accept standard charging and meet the mission requirements.

Passenger aircraft generally have multiple flights per day and require quick turnaround times between routes. These aircraft thus do require fast charging to turn an aircraft around in less than 30 minutes. Targeting a 20-minute turnaround similar to the trainer aircraft capabilities would require a 3C (charging the battery at a rate three times its energy capacity—3x kW per kWh of capacity) charge rate of the energy to replenish. This fast charge route forecasts the recharge kilowatts needed to service these aircraft.

2.3.3.2 Aircraft Type

This forecast uses the data collected and referenced above for each of the three aircraft. This model assumes that the P-Volt and hybrid Caravan aircraft would be developed and enter into service by 2025 (year 2 of the time period)[14]. The hybrid King Air requiring increased energy density would be developed and enter into service in 2028 during the latter horizon period.

The specific aircraft forecasted per route is based on range capabilities and the time horizon of the aircraft. Those routes less than 85 nm are able to operate with the P-Volt whereas any greater distances would require one of the hybrid aircraft.

2.3.3.3 Logistic Daily Flights

For the logistic routes, Alpine Air currently operates a daily route that departs Salt Lake City, stops first in Cedar City, then lands in St. George before returning to Salt Lake City. The Cedar City to St. George route is only a 44 nm distance currently operated by the same large airplane. This forecast assumes that a cargo operator would prefer to operate this short route from Cedar City to St. George with a more economic aircraft. The all-electric aircraft could service this route as a feeder with the Salt Lake to Cedar City route serviced by the larger aircraft. Alpine Air has another similar daily route from Salt Lake City to Vernal to Price and back to Salt Lake.

The model forecasts the cargo operator will initially trial these two routes between Cedar City and St. George and between Vernal and Price. As the economics of operating electric aircraft are obtained the operator will begin expanding its electric fleet supplementing or replacing its existing routes with electric-capable aircraft. The latter period also forecasts increased aircraft volume required per route. The forecast assumes multiple smaller electric aircraft would be utilized over one large traditional aircraft due to lower operating costs of the electric aircraft (offsetting initial purchase costs, which could be higher for a larger quantity of aircraft).

2.3.3.4 Passenger Daily Flights

As previously mentioned, passenger routes are derived from existing routes and forecasted new routes. These routes follow an east/west flight corridor and a north/south flight corridor. Salt Lake City is not specifically identified as its own hub in the outlined forecast as all of the other designators pass through or incorporate Salt Lake City in the route matrix. These routes and flight corridors forecast a network model as an alternative to the traditional hub-and-spoke model.

Vernal Forecast: SkyWest currently operates a 50-seat CRJ aircraft twice daily from Vernal, Utah to Denver, Colorado. The Vernal route forecasts that this could be replaced by hybrid aircraft carrying 9-11 passengers. This operation is expected to operate 4-8 times daily, better eliminating time displacement for commuters and travelers. The Vernal study indicates that, as economic constraints are removed, additional Vernal to the Greater Wasatch front flights could be added for commuters. The forecast projects the daily volume to increase as this becomes more prevalent as an economic alternative for commuting.

Canyonlands Forecast: Currently SkyWest operates a daily 50-seat CRJ route from Moab, Utah to Denver, Colorado on behalf of United Airlines. SkyWest has also previously operated a second route for Delta Airlines from Salt Lake to Moab. With Moab as a key tourism destination, this model forecasts this demand being replaced by more frequent smaller electric aircraft. Additional East/West arrival-and-departure locations connected to Canyonlands Regional Airport would also begin to progressively be added. Electrification eliminates the specific hub-and-spoke airline model allowing for a greater network effect of passengers traveling from smaller regional airports near their home to tourist destinations.

Logan Forecast: The Logan-based route forecast captures new flight corridors connecting the state from Logan in the north down to St. George in the south. These routes are commuter-based routes and the model forecasts much like other public transit modes where the aircraft will make multiple stops along its ultimate flight path. Logan was forecasted as a likely operating location given projected infrastructure to support electric aircraft already established because of USU flight school initially adopting an electric fleet.

These operations expect to leverage relief airports such as Bountiful or South Valley Regional as alternatives for commuters traveling to the Wasatch Front that don’t need Salt Lake International Airport as the final destination. This commuter path would also connect to Provo and down to Cedar City and St. George. These routes grow in volume as aviation commuting grows over the forecast period.

St. George/Cedar City Forecast: Current daily routes operated by airlines through St. George or Cedar City are highlighted in Table 2. The forecast projects these routes to be supplemented or replaced with hybrid aircraft. As with the other routes, the lower operating economics of the electric fleet will allow airlines to run more frequent routes with smaller aircraft than are currently being used. The model forecasts a conservative volume scaling throughout the observed time period.

Table 2. Daily operating routes from SGU airport[15]

Route	Airline (Partner Airline)	Aircraft	Flight/Day
SLC/SGU	SkyWest (Delta)	50-Seat CRJ	4
SLC/CDC	SkyWest (Delta)	50-Seat CRJ	2
SGU/DEN	SkyWest (United)	50-Seat CRJ	2
SGU/PHX	SkyWest (American)	50-Seat CRJ	1
SGU/KLAS	Westair Industries	Cessna Caravan 208	1
CDC/KLAS	Westair Industries	Cessna Caravan 208	1
SLC/SGU/Others	Aero Charter	Pilatus PC-12	1

2.3.4 Research Task 2: Preliminary Analysis and Results

Thin-haul adoption projects and energy requirement forecasts are found in Table 14. Thin-haul-capable aircraft will likely enter the market following electric trainers but in advance of EVTOL aircraft. These operations will provide core new transportation networks, especially for commuter travel within the state of Utah. The timeline of these operations will be able to utilize infrastructure initially installed for flight schools and further build out additional airport electrified locations. The contribution of electrified thin-haul operations along the Wasatch Front to the statewide electrification forecast is a significant driver to overall energy demand. These operations will prepare many airports for the coming of AAM operations. These east/west and north/south electric corridors are also an important operational enabler for future AAM routes. AAM will further be able to connect travelers or goods to more direct end destinations after the longer flight patterns are met with thin-haul or traditional air travel.

2.4 Research Task 3: AAM Introduction and Electrification Forecast

2.4.1 Research Task 3: Background and Assumptions

Advanced Air Mobility (AAM) is typically focused on the implementation of small aircraft in local cargo and passenger transportation activities. The general trend in the developing AAM industry is to consider electrified vertical-takeoff-and-landing (EVTOL) aircraft for these roles due to their innate ability to operate flexibly and minimize noise and fuel exhaust pollution in space-constrained and already-congested urban environments.[16] Additionally, the constant weight and balance attributes of battery-powered aircraft and their high potential for automation relative to conventionally fueled aircraft simplify the operational requirements and constraints for AAM operators and open opportunities for cost savings and safety improvements over conventional technologies[17].

For this component of the statewide aviation electrification forecast, publicly available data regarding the availability and performance of market-leading EVTOL aircraft were gathered and used together with publicly available traffic data and observable population centers and points of interest along the Wasatch Front corridor to identify a set of feasible AAM routes and operational schedules between 2024 and 2030. Consistent with the intent of this project, the data and analysis described in this section are not intended to be a complete forecast of AAM in Utah during the stated period. Rather, they are intended to present the development of a methodology and tool set that can be used to develop an exhaustive forecast and to provide a preliminary examination of a potential route for adoption, operation, and energy and power demands of electrified AAM along the Wasatch Front.

2.4.2 Research Task 3: Data Summary

Table 3. EVTOL aircraft projected to enter service in 2022-2030 used as models for AAM operating parameters

Manufacturer/ Developer	Aircraft	Projected Range (nm)	Projected Energy Capacity (kWh)	Projected Energy Consumption Rate (kWh/nm)	Projected Flight Speed (nm/hr)
Joby[18]	S4	150	200	1.33	
Archer[19,20]		60	75	1.25	130.3

Manufacturer/ Developer	Aircraft	Projected Range (nm)	Projected Energy Capacity (kWh)	Projected Energy Consumption Rate (kWh/nm)	Projected Flight Speed (nm/hr)
Vertical Aerospace[21]	VX4	100			
Embraer Eve[22]		60*			108.5
Lilium[23]		67.5**			
Airbus[24,25]	CityAirbus	50			64.8
Average Values		**81.3**	**137.5**	**1.29**	**101.2**
*Range Not Including Reserves **Average between min and max projected					

EVTOL Range and Energy Consumption: The data representing this forecast is provided in Table 15 in Appendix A.3 AAM Forecast. The aircraft data used to develop the EVTOL operational limitations and profiles used in the forecast are presented in Table 3. Note that, while the average projected range of the six aircraft considered in the table is just over 80 nautical miles (nm), in this study the maximum EVTOL route range was limited to 30 nm, based on the FAA's existing 30-minute fuel reserve for small aircraft:

- The reserve is calculated based on the energy required to cruise for 30 minutes[26]
- Assuming an average cruise speed of 100 nm/hr per Table 3, and 30 minutes reserve, the vehicle should be able to fly 50 nm
- Allowing for a 50 nm reserve requires the vehicle to restrict its operating range to 30 nm

Table 4. Proposed AAM hubs along Utah's Wasatch Front with rationales for AAM infrastructure development

Proposed AAM Hub	Rationale for AAM Development
OGD (Ogden)	Northern Wasatch Front population center
Layton/South HAFB	Northern Wasatch Front population and healthcare center, located along major commuting route
North Wasatch Ski Resorts (Snowbasin, Powder Mountain, Nordic Valley)	Tourist draw
SLC (Salt Lake International)	International transportation hub
City Creek	Central Wasatch Front commercial, business, and population center, central to UDOT surface public transportation system
University of Utah	Central Wasatch Front research, education, and healthcare center
U42 (South Valley)	SLC relief airport, western Wasatch Front population center

Proposed AAM Hub	Rationale for AAM Development
The Point (Draper)	Southern Wasatch Front commercial and business center, located along major commuting route, planned UDOT transportation hub and new urban living center
Central Wasatch Ski Resorts (Snowbird, Alta, Solitude, Brighton)	Tourist draw
Thanksgiving Point	Southern Wasatch Front commercial, business, and population center
Park City	Tourist draw, Eastern Wasatch Front commercial and population center
PVU (Provo)	Southern Wasatch Front aviation hub, population center
Provo City Center	Southern Wasatch Front commercial, business, population, and healthcare center
Brigham Young University	Southern Wasatch Front research and education center

AAM Operational Hubs: This study proposes several operational hubs for AAM introduction along Utah's Wasatch Front Corridor (Weber, Davis, Salt Lake, Summit, and Utah Counties). They are provided in Table 4 and the proposed routes between them are provided in Table 15. These locations were chosen based on their proximity to areas with high concentrations of surface traffic and population, commercial, business, tourism, healthcare, and research centers (i.e., the most highly frequented destinations along the Wasatch Front). Similar destination types were used in studies like that produced by Uber in 2016.[16]

2.4.3 Research Task 3: Forecast Development Methodology

AAM Routes: AAM routes were selected based on several criteria:

- AAM hubs proposed for adjacency/accessibility to (see Table 4):
    - Major population, commercial, and business centers
    - Medical centers
    - Research/educational centers
    - Existing and planned public transportation hubs
    - Existing non-public transportation centers (including established airports)
    - Tourist destinations

    - Commuter routes adjacency to accessibility by surface transportation
- Origin/Destination closeness to the potential hub sites identified in Table 4
- Distance between potential origin and potential destination (less than the 30-mile general operating range identified in Section 2.4.2)

Daily Flights: The number of daily flights for each route is based on the following factors:

- Projected availability of certified, mass-produced EVTOL aircraft
    - The most advanced EVTOL developers (e.g., Joby, Archer) have cited planned FAA certification sometime between 2024 and 2025[20,22,25]
    - At least a small number of certified, commercial aircraft should be available by 2026, as demonstrated in the early adoptions for some novelty/tourist application in that year in Table 15
    - Assuming multiple EVTOL aircraft coming online in the following decade, we represent EVTOL ubiquity in 2030.
- Observed ground traffic between route origin/destination
    - Existing traffic volumes between EVTOL hubs were observed in the publicly available annual average daily traffic (AADT) data published by UDOT[27]
    - These volumes were qualitatively assessed to assign the number of daily flights for each route, with routes along high-surface-traffic-volume corridors being assigned more daily flights than routes along low-surface-traffic-volume corridors (e.g., routes that trend north/south along the I-15 corridor, Utah's main surface traffic artery, were allotted more daily flights than east/west routes)
- AAM operator resources and operating profiles
    - The AAM forecast provided in Table 15 consists of four hypothetical AAM operators with the following general mission and constraints
        1. A shuttle service operating between the OGD and SLC airports focused on running a small number of routes multiple times per day
            - Limited number of short-range aircraft; slow growth over time
        2. A general service for the greater Salt Lake City metropolitan area with many routes between SLC and other regional airports and the various social and economic foci identified at the beginning of this section

        - Many aircraft operating varied-range routes; a first mover with significant growth over the period under examination
    3. A business-class service focused on shuttling between the SLC and PVU airports and the business and commercial hubs in Salt Lake City, southern Salt Lake County, and northern Utah County
        - Many long-range aircraft operating a small variety of routes; not a first mover, but high growth over a short period of time
    4. A tourist/shuttle service providing transportation between the SLC and OGD airports and the central and northern Wasatch Mountain range ski resorts (e.g., Snowbasin, Park City/Canyons, Snowbird, Brighton)
        - Fewer, long-range aircraft operating multi-stop routes; a first mover with measured growth over time
- The four hypothetical AAM operators are intended to provide an exploration of how operators might approach each market segment they represent and are not representative of EPS's projection of the full Wasatch Front AAM market from 2026 to 2030

Energy and Power Requirements: The energy and power requirements for AAM operators are based on the following calculations and assumptions, which are also summarized in Figure 2.

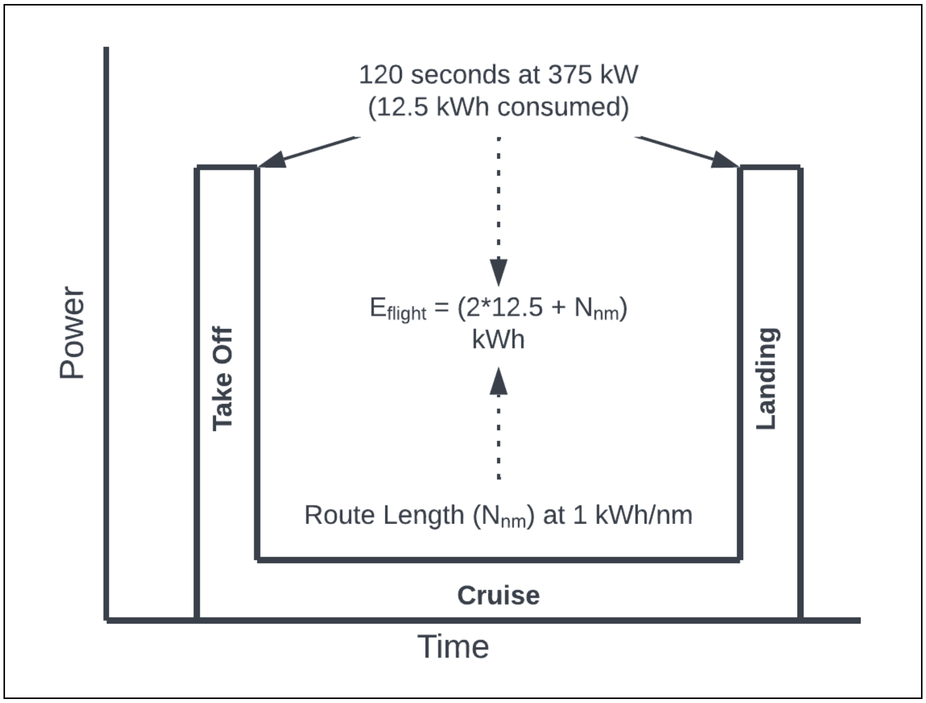

Figure 2. Representative EVTOL power/energy consumption profile[16]

- EVTOLs require large amounts of energy at high power for the hover phases of flight (i.e., takeoff and landing)
- EVTOLs can cruise at relatively low power levels
- Total energy consumption for each route is computed as $E_{flight} = (2 * 12.5 + N_{nm})$ where E_{flight} is the energy consumed during the flight in kWh and N_{nm} is the length of the route in nautical miles, as illustrated in Figure 2
- The total energy consumed by EVTOL flights each day along each route is simply a multiple of the energy consumed by a single flight and the number of flights per day along the route $E_{flights} = N_{flights} * E_{flight}$ where $E_{flights}$ is the total energy consumed by the flights along the route each day, $N_{flights}$ is the number of flights along the route each day, and E_{flight} is the energy consumed by a single flight along the route
- The general assumption for charging operation in AAM operations is that charging as quickly as possible is optimal. We assume a 3C charge rate, as indicated in the column “kW” in Table 15

2.4.4 Research Task 4: Preliminary Analysis and Results

The contribution of AAM operations along the Wasatch Front to the statewide electrification forecast is discussed in detail in Section 2.5. The following points summarize the observations resulting from the development of the AAM forecast.

- The proposed AAM adoption and operational scenarios presented in the forecast are forward-looking and based on the timelines for development and availability of segment-leading EVTOL developers and manufacturers
- AAM operations in Utah may initially target hubs with easy access to critical services and amenities that are associated with a culture that values convenience, accessibility, and novelty over cost savings
- In the next decade, AAM proliferation along the Wasatch Front (and in other urban areas) may develop an operational pattern focused on short "hops" between key population, commercial, business, and tourism centers with fast refueling times and minimized non-operational time

2.5 Synthesis of Data from Tasks 1-3: Statewide Aviation Electrification Forecast

2.5.1 Cross-Segment Adoption Forecast

Each of the electrified aviation forecasts discussed in Sections 2.2, 2.3, 2.4 is independently useful, but a synthesis of the data from all three forecasts into a statewide aviation electrification forecast provides much greater insight than any one of the three industry segments does individually. This section outlines the data developed from combining the three forecasts and the key observations made by so doing, namely, a view of the impact of electrified aviation on air traffic along the state's traffic corridors and at its airports, and the insight into demands that the new electrified aircraft operations will impose on the electrical infrastructure at airports in the state.

2.5.2 Data Summary

Appendix A.4 Combined Statewide Forecasts contains the full dataset created by combining the data created in the flight school, thin-haul/commercial, and AAM aviation. As described in the previous section, the per-year daily flight data from each of the three forecasts was combined to identify the following information:

- The number and type of electrified flights at each airport in the state (the airports identified as potentially supporting electrified aircraft traffic are listed in

Airport Location	Airport Code	Airport Location	Airport Code
Parowan, UT	1L9	Pocatello, ID	PIH
Billings, MT	BIL	No Airport, UT	Park City*
Brigham City, UT	BMC	Phoenix, AZ	PHX
Bountiful (Skypark), UT	BTF	Price, UT	PUC
Cedar City, UT	CDC	Provo, UT	PVU
Moab, UT	CNY	Rock Springs, WY	RKS
Denver, CO	DEN	Rexburg, ID	RXE
Elko, NV	EKO	St. George, UT	SGU
ELY, NV	ELY	Salt Lake International, UT	SLC
Wendover, UT	ENV	Spanish Fork, UT	SPK
Heber City, UT	HCR	Twin Falls, ID	TWF
Idaho Falls, ID	IDA	No Existing Airport, UT	Thanksgiving Point*
Jackson, WY	JAC	No Existing Airport, UT	The Point*
Hailey, ID	KSUN	West Jordan (South Valley), UT	U42
Las Vegas, NV	KLAS	Vernal, UT	VEL
Logan, UT	LGU	Winnemucca, NV	WMC
Nephi, UT	NPH		

- Table 12 and the quantity of flights by aviation industry segment is provided in Table 19 in Appendix A)
- The energy required by flights recharging at each of the identified airports (Table 18 in Appendix A)
- The power capacity (i.e., the rate at which energy is provided) required to recharge electric aircraft at each of the identified airports (referenced in Table 18 and Table 20 and directly addressed with mild and extreme multi-aircraft simultaneous charging scenarios in Table 21 and Table 22 in Appendix A)

Table 5. Candidate airports to support aviation electrification in Utah

Location	Airport Code	Latitude	Longitude
Parowan	1L9	37.86	-112.82
Brigham City	BMC	41.55	-112.06
Bountiful (Skypark)	BTF	40.87	-111.93
Cedar City	CDC	37.70	-113.10
Moab	CNY	38.75	-109.75
Denver	DEN	39.85	-104.67
Wendover	ENV	40.72	-114.03
Heber City	HCR	40.48	-111.43
Las Vegas	KLAS	36.08	-115.15
Logan	LGU	41.79	-111.85
Nephi	NPH	39.74	-111.87
Ogden	OGD	41.20	-112.01
No Airport	Park City*	40.66	-111.51
Phoenix	PHX	33.43	-112.01
Price	PUC	39.61	-110.75
Provo	PVU	40.22	-111.72
St. George	SGU	37.04	-113.51
Salt Lake International	SLC	40.79	-111.98
Spanish Fork	SPK	40.15	-111.67
No Existing Airport	Thanksgiving Point*	40.43	-111.89
No Existing Airport	The Point*	40.52	-111.91
West Jordan (South Valley)	U42	40.62	-111.99
Vernal	VEL	40.44	-109.51

2.5.3 Air Traffic Implications

Two of the industry segments examined in this study, flight school and thin-haul/commercial, currently exist in a well-established state, operating various sizes of vehicles through the airports listed in Table 5. The third industry segment, AAM, has yet to materialize in an operational context, but is poised to emerge in the coming decade, with hundreds of millions in investment globally and dozens of companies, both established OEMs and startups, as an innovative and influential leading segment in transportation. The electrification forecasts developed by this study promise a variety of changes to the volume of air traffic in Utah's airports and to the ways in which that traffic is controlled and regulated.

Flight Schools: To the degree to which they were explored in this work, the impact of electrifying existing flight school and thin-haul/commercial operations on air traffic, both at airports and along flight corridors, is limited. Flight schools' traditional operation is largely centered around their base airport and a few satellites (e.g., UVU flight school is centered at PVU and frequently flies at SPK, NPH, HCR, and U42). The flight school electrification forecasts developed in this study point to a phased replacement of existing operating aircraft (see Appendix A,

Airport Location	Airport Code	Airport Location	Airport Code
Parowan, UT	1L9	Pocatello, ID	PIH
Billings, MT	BIL	No Airport, UT	Park City*
Brigham City, UT	BMC	Phoenix, AZ	PHX
Bountiful (Skypark), UT	BTF	Price, UT	PUC
Cedar City, UT	CDC	Provo, UT	PVU
Moab, UT	CNY	Rock Springs, WY	RKS
Denver, CO	DEN	Rexburg, ID	RXE
Elko, NV	EKO	St. George, UT	SGU
ELY, NV	ELY	Salt Lake International, UT	SLC
Wendover, UT	ENV	Spanish Fork, UT	SPK
Heber City, UT	HCR	Twin Falls, ID	TWF
Idaho Falls, ID	IDA	No Existing Airport, UT	Thanksgiving Point*
Jackson, WY	JAC	No Existing Airport, UT	The Point*
Hailey, ID	KSUN	West Jordan (South Valley), UT	U42
Las Vegas, NV	KLAS	Vernal, UT	VEL
Logan, UT	LGU	Winnemucca, NV	WMC
Nephi, UT	NPH		

Table 12) with electric aircraft over the next decade instead of a significant uptick in operational volume; thus, the anticipated impact on air traffic is, for the time being, minimal.

Thin Haul/Commercial: The same observation of small impact made for flight schools applies to the impact on statewide air traffic of electrifying the existing and potential thin-haul/commercial routes proposed in this study (see Appendix A, Table 13 and Table 14). Figure 3 shows that the proposed additional volume of air traffic in and out of SLC International Airport —12 additional flights—is relatively small compared to the hundreds of arrivals/departures that traffic the airport daily.

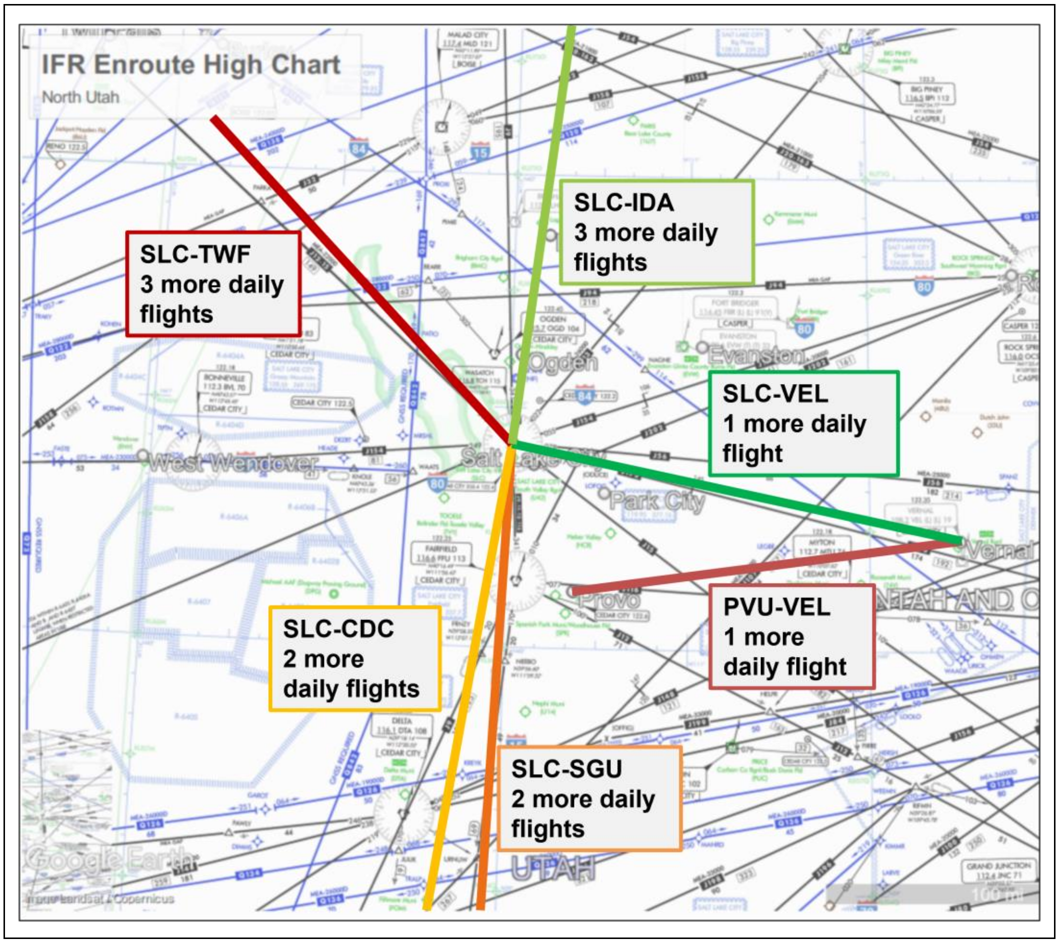

Figure 3. IFR Enroute High Chart (>18,000 feet altitude) around SLC International Airport overlaid with projected 2030 electrified thin-haul/commercial operations

There are, however, two caveats in evaluating impact on airport traffic. First, in the smaller airports examined, the addition of flights on the order of 10 flights per day could be overwhelmingly significant, so an analysis of the impact of new thin-haul/commercial flights on airport traffic must be conducted on the relative, local level. Second, only the logistical routes operated by Alpine Air and some of the most common passenger routes in the state were examined in this study with the express purpose of developing a method for estimating the energy and power demands of electrified thin-haul/commercial operation, not of conducting an exhaustive analysis of all potentially electrifiable thin-haul/commercial operations in the state.

AAM: The inherent newness of AAM technology and operation dictates that any AAM traffic will directly add to existing air traffic from other industry segments. The four example AAM operations shown in Table 15 (Appendix A.3 AAM Forecast) provide an informed view of how

AAM traffic might develop along the Wasatch Front corridor, with hundreds of new routes being operated daily from hubs at OGD, SLC International Airport, PVU, and at the commercial and business hubs to the north and south of the junction of Salt Lake and Utah counties (i.e., The Point and Thanksgiving Point in Table 15.

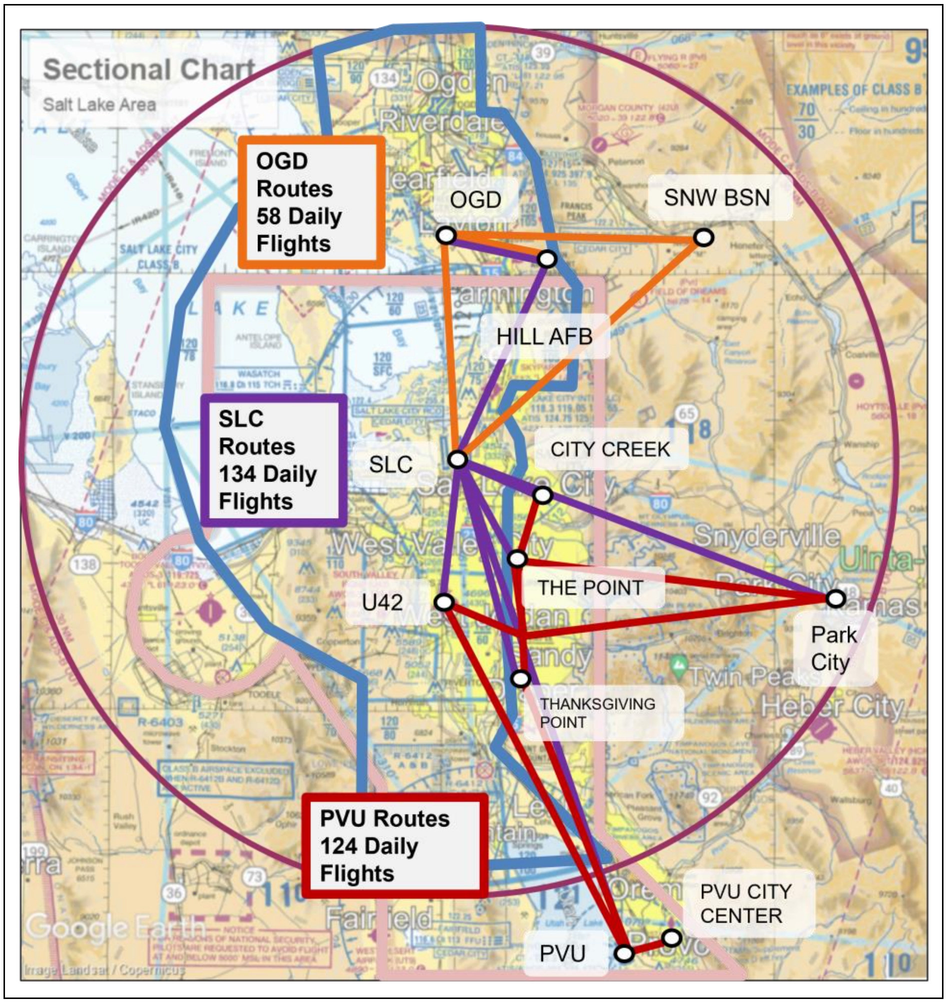

Figure 4. Sectional Chart over Weber, Davis, Salt Lake, Summit, and Utah Counties overlaid with potential low altitude (<4,000 feet altitude) AAM routes (straight, colored lines between labelled AAM hubs and airports). Class B* airspace (thick blue shape), Class C* airspace (thin purple circle), and Class E* airspace (thick pink shape) are emphasized.

As with the thin-haul/commercial forecast presented in this study, the AAM forecast shown in full in Table 15 and visualized in Figure 4 is intended to provide sufficient information to develop a method for estimating the energy and power demands of electrified AAM operation, and is not exhaustive in nature. However, the significant number of low altitude flights shown in Figure 4 provides a clear indication of two probable realities. First, AAM hubs, including existing airports, may have to accommodate a large volume of arrivals/departures from vehicles that do not operate in the same way as the fixed-wing traffic that those airports currently serve. Those hubs should prepare both to regulate the large volume of flights (including by preparing to provide parking and security for the passengers of those flights) and to provide logistical services to various sizes and brands of non-fixed wing aircraft. Second, the volume of flights crossing into Class B (the heavily regulated airspace up to 10,000 ft. above sea level around major airports like SLC)* airspace and operating almost entirely within Class C (the regulated airspace up to 4,000 ft. above ground level around airports with control towers)* airspace shown in Figure 4 may require a significant overhaul or at least augmentation of air traffic control along the Wasatch Front.

**Note: Definitions of airspace classifications, restrictions, and their significance can be found on the FAA's website https://www.faa.gov/air_traffic/publications/atpubs/aip_html/part2_enr_section_1.4.html* [30,31]

2.5.4 New Energy and Power Demands at Airports

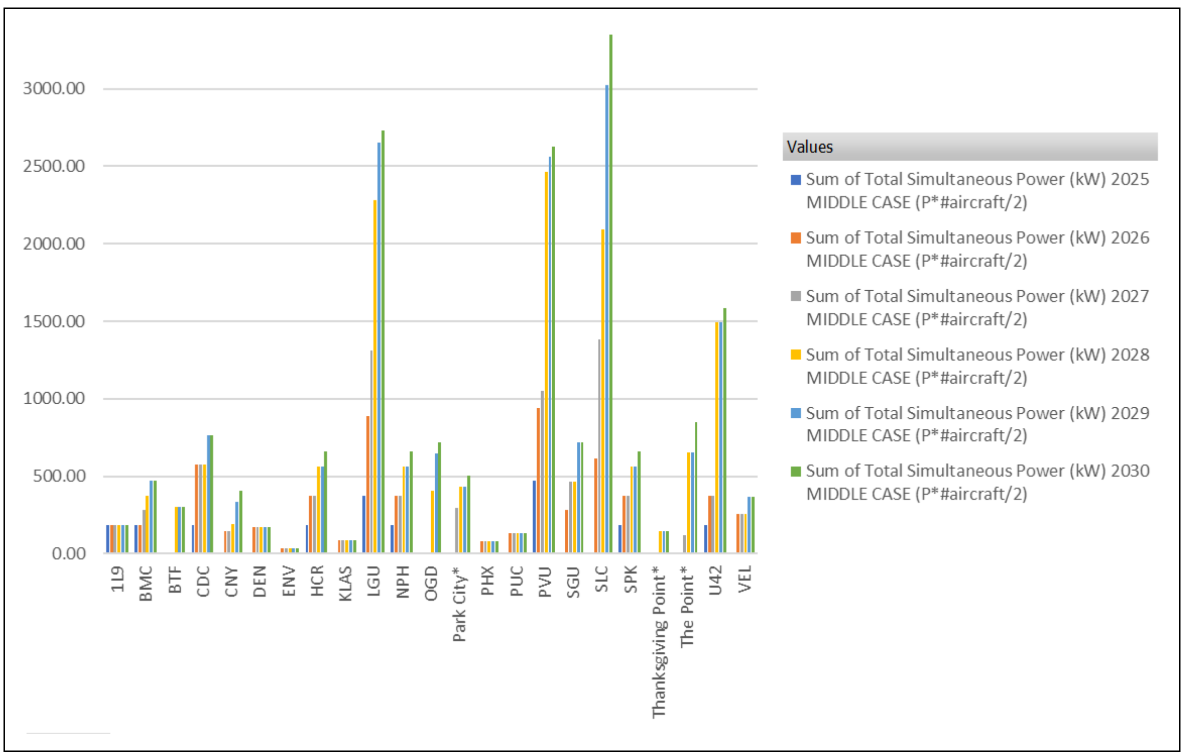

Figure 5. Power requirements at each airport assuming simultaneous charge of up to two aircraft simultaneously. Y-axis is in units of kW.

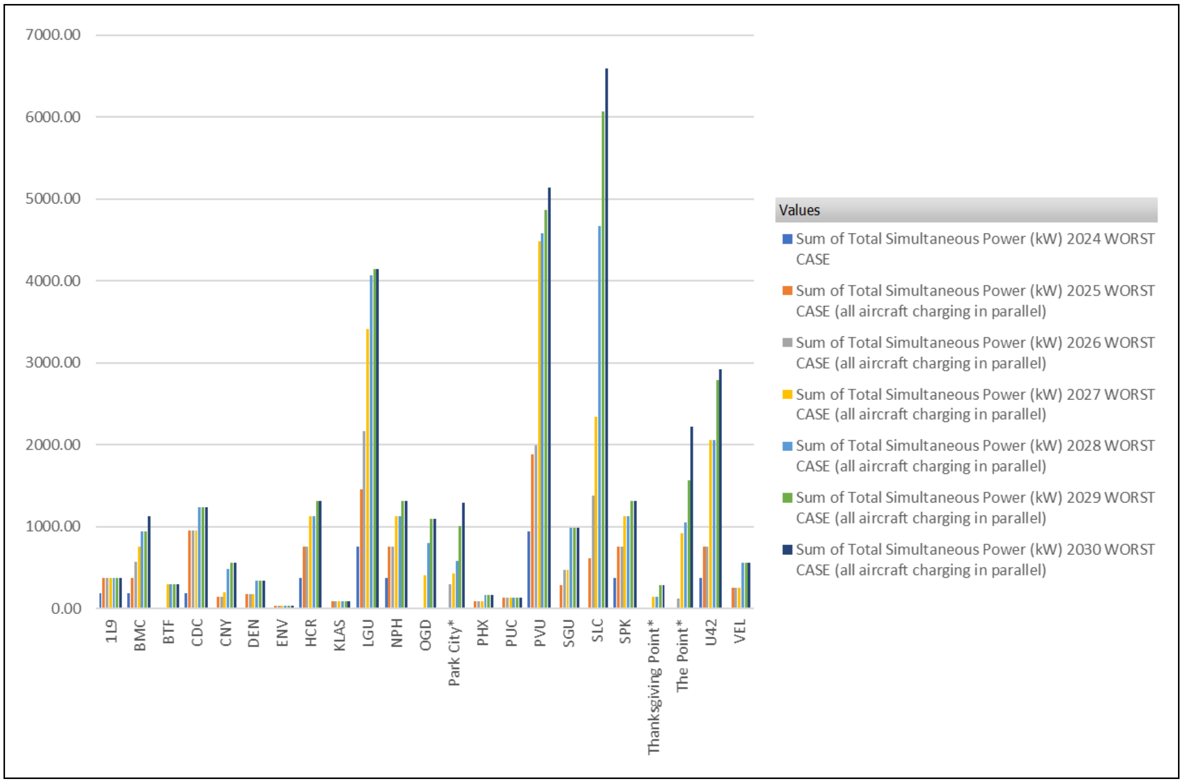

Figure 6. Power requirements at each airport assuming simultaneous charge of all aircraft at each airport charging simultaneously. Y-axis is in units of kW.

Figure 5 and Figure 6 summarize the data provided in Appendix A.4 Combined Statewide Forecasts that estimates the power demanded by the combined aircraft operated by flight schools, thin haul/commercial, and AAM operators at each airport in Utah that could support electrified aviation. Figure 5 provides a baseline estimate that assumes up to two aircraft charging simultaneously at each airport, based on the number of daily flights presented in Appendix A. Figure 6 provides a more conservative estimate, which assumes that all electric aircraft served daily at each airport will charge simultaneously—a scenario that presents the absolute maximum grid capacity (power) load demanded by the electrified aviation industry segments examined in this study. Section 2.6 discusses the implications of these power demands at length.

2.6 Research Task 4: Electrified Aviation Energy and Power Requirements

2.6.1 Research Task 4: Background and Assumptions

Based on forecasted adoption of aviation electrification, it is possible to estimate the electricity needs of the fleet recharging at each airport. The total daily energy for an airport is the total energy consumed by all the aircraft that recharge at that airport on a given day. Knowing the typical daily number and types of aircraft arrivals and departures, this number is computed by adding together the energy consumption of each aircraft on inbound flights to the airport as shown in the following equation $E_{tot}^{daily} = \sum_{i}^{N_{arrivals}} E_i$, where E_i is the energy consumed by flight i before landing at the airport and $N_{arrivals}$ is the total number of arrivals at the airport each day.

Computing the worst-case highest demand at an airport, however, is more difficult. If there is only one charger available, the installed grid capacity will need to be at least the rated capacity of that charger, and the aircraft will have to use it one at a time. However, if there are enough chargers, it is possible for many aircraft to charge simultaneously, creating a significant instantaneous peak load, despite using the same amount of electrical energy. The airport peak power values in Figure 6 and Appendix A, Table 22 show the estimated maximum demand for several airports in Utah.

The installed maximum charging capacity is important to know because it dictates the size of the distribution grid equipment necessary to supply an airport and because it will be a major component in an airport's electricity bill. The power grid is not built to handle simply the average power flowing from generators to customers, but, rather, must be sized to handle the absolute maximum peak demand flowing through it, even if this peak only happens for an hour in the year. As a result, since the grid must be sized to meet the installed charging capacity, customers with higher installed power capacity will be more expensive to serve even if they're using the same amount of electrical energy as a neighbor with installed power capacity close to its average power. The maximum possible charging power capacity is a useful indicator of how much the grid must be upgraded to support new loads like electrified aviation.

In many cases when a large new electricity customer seeks to connect to the grid, it is necessary for the utility to upgrade equipment feeding the customer, which can be an expensive process. For example, in 2020, distribution line upgrades could cost about $1.6M/mile for overhead lines and nearly twice as much for underground lines, and upgrades to an existing substation could cost over one million dollars, with new substations costing several millions of dollars. Broken up into 1-kW increments, this works out to about $129-300 per kilowatt of upgrades needed for the utility substation and customer transformer in addition to the line upgrade costs, which depend mostly on length of line upgrades, not power capacity.

The need to perform these upgrades is dictated by the installed power capacity of the new customer, so customers with higher installed power capacity will require more upgrades than customers without the capacity to pull large amounts of instantaneous power. For some utilities like Rocky Mountain Power, if the customer does not consume enough energy to cover a certain portion of the upgrade costs over a few years through their regular utility bill, the customer will need to help cover the upgrade costs in addition to their electricity bills, which can be a significant impediment to installing high-power charging equipment.

As new charging loads at the airports are deployed incrementally, the energy consumption of electrified aviation will grow with time, but the installed power capacity of an airport's charging equipment may not. For example, if an airport starts with the need to accommodate charging for one aircraft, it will need one charger to supply that energy. As the airport begins to add additional aircraft to its charging needs, the single charger may be sufficient to provide the additional energy with no change to the installed capacity or peak power demand. From the utility's perspective, one or a few aircraft may not create enough energy demand to cover the cost of the necessary grid upgrades to support the charger, and before installation the utility may require the airport to pay upfront for the upgrade costs, even though as additional aircraft are added, their energy demand would cover the upgrade costs. Hence, mechanisms and programs like the development of a mobile charging fleet that supplements small airports' fixed electric infrastructure should be developed to defer the required upgrades to a later date when there are enough aircraft to cover the grid upgrade costs.

Additionally, the airport's monthly peak power demand, measured as the highest power demand in any fifteen-minute period in the month, has a significant impact on a customer's electricity bill. For example, Rocky Mountain Power Rate Schedule 6, which is common among larger commercial and industrial customers, has two major components to the total bill[28]. There is a rate of 3.9¢/kWh of total monthly energy used. On top of the energy charge, there is a $17.26/kW energy charge which is multiplied by the customer's peak demand.

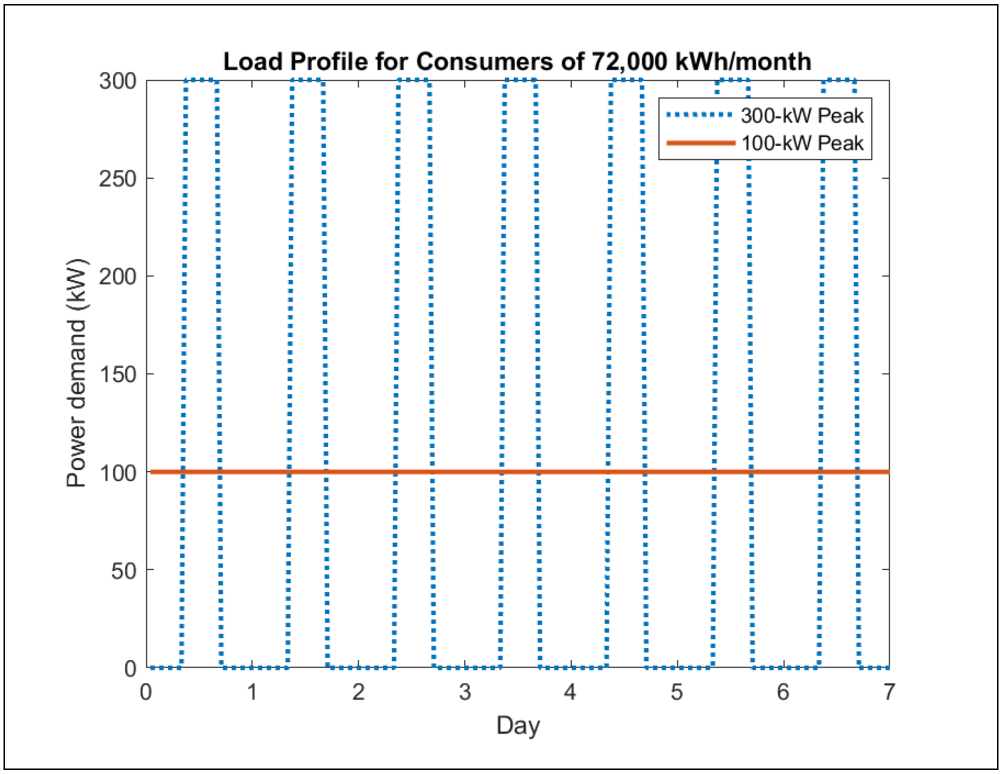

Figure 7. Representative customer load profiles with peak indicators

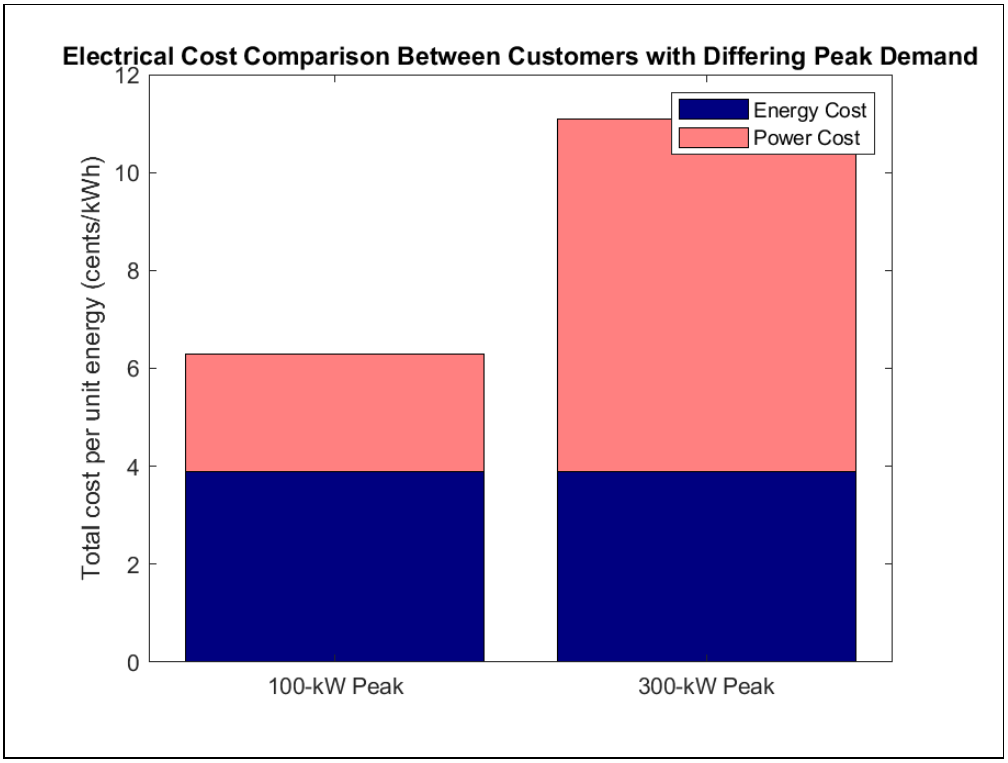

Figure 8. Electricity cost in cents/kWh for energy and peak power loads

For a customer with a flat 100-kW load, the total energy use is 72,000 kWh, and the peak demand is 100-kW, resulting in a monthly bill of $4,534 or 6.3¢/kWh. A customer that uses 300 kW of power for eight hours a day will still consume 72,000 kWh in a month, but with a peak demand of 300 kW, the monthly bill will be $7,986, or 11.1¢/kWh—a significant increase. The load profiles and comparison of energy costs are shown in Figure 7 and Figure 8. To properly predict the electricity costs of electrified aviation, it is important to know the worst-case peak demand.

For some electrical distribution networks, there may be ample capacity to support electrified aviation, while others may not be built to handle such large loads. The airports that fall into these categories are discussed in Section 2.6.3. It is important to know in advance how much grid capacity is available to support electrified aviation because making any necessary upgrades is an expensive and time-consuming process. As described above, utilities build distribution networks to support the worst-case absolute peak demand. As a result, the grid likely has enough capacity to meet the peak demand of all customer transformers combined. Since the peaks do not occur simultaneously in real life, the true maximum total power is much lower than this value, so the total transformer capacity acts as a conservative estimate of grid capacity.

2.6.2 Research Task 4: Data Summary

A key input to compare estimated grid capacity with worst-case airport power requirements is the airport power requirements themselves, which are computed as described in previous sections.

As described in Section 2.6.3, the sizes and locations of electrical customer transformers can be used to estimate the grid capacity. The transformer data was provided by Rocky Mountain Power, so the data is only available for their service territory, which excludes many municipal utilities in Utah that feed some airports. Consequently, for this report transformer data was not obtained to estimate grid capacity for all airports in Utah.

The estimated utilization of existing distribution networks, however, can be computed by comparing capacity with utilization of other distribution networks. By using electrical load data from one substation, the peak all-time demand can be found and used as the upper limit for utilization of existing equipment. It is assumed that utilization on most distribution networks will be very similar to the substation and distribution network for which data is available.

2.6.3 Research Task 4: Data Synthesis Methodology

The total power distribution network capacity surrounding each airport can be estimated by the total power capacity of nearby customer transformers. For the purposes of this project, transformers within one mile of each airport were considered to compute the nearby grid capacity. Using data derived from information provided by Rocky Mountain Power (RMP) to USU, it was possible to compute the total nearby grid capacity for several airports, as shown in Table 6, under the column Estimated Total Grid Capacity.

Table 6. Estimated 2022 total grid capacity, 2022 available grid capacity, and projected 2030 electrified aviation capacity demand at RMP-serviced airports in Utah; data derived from information provided by RMP to USU

Location	Peak Demand 2030 (kW)	Est. Total Grid Capacity	Est. Available Capacity (kW)	Capacity Surplus (2030)	Airport Fraction of Capacity
Parowan	376.18	171.27	137.01	-239.16	275%
Cedar City	1232.16	5300.08	4240.06	3007.90	29%
Ogden	1096.58	5103.87	4083.10	2986.51	27%
Price	134.07	24.94	19.95	-114.12	672%
Salt Lake Int'l	6590.58	29218.17	23374.54	16783.95	28%
West Jordan (South Valley)	2916.53	5946.06	4756.85	1840.32	61%
Vernal	557.03	1654.45	1323.56	766.54	42%

While the transformer data is a good indicator of total grid capacity, a more useful indicator is available grid capacity. As a new load on the grid, electrified aviation will be connecting to a network that already has some capacity being occupied by existing loads. After all, the total grid capacity estimate is based on transformers that feed existing customers. Using historical data, it is possible to compare peak measured power demand at an electrical substation with its rated capacity. As shown in Figure 9, the recorded peak power demand at this substation in downtown Salt Lake City is much lower than the rated capacity at all hours of the day throughout the year. As a result, the available grid capacity is about 20% lower than the total grid capacity, as shown in Table 6, in the column labeled Estimate Available Capacity.

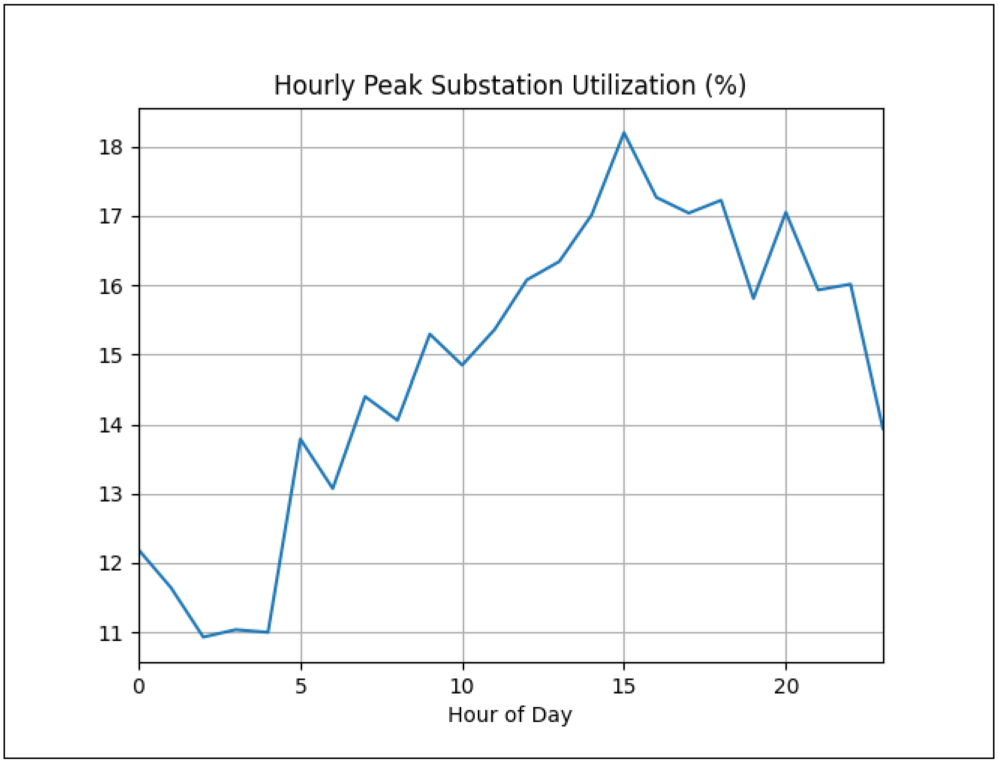

Figure 9. Hourly peak substation utilization in downtown Salt Lake City, UT, 2022

It is important to reiterate that this data was not available for all airports in Utah, nor for none outside of Utah. Since the grid capacity is computed from Rocky Mountain Power transformer data, it excludes areas served by municipal or other non-RMP utilities, like Provo, Brigham City, Denver, and others. However, it is likely that these non-RMP utilities use similar infrastructure design practices and have similar margins between capacity and peak demand as the RMP-supplied airports do.

2.6.4 Research Task 4: Preliminary Analysis and Results

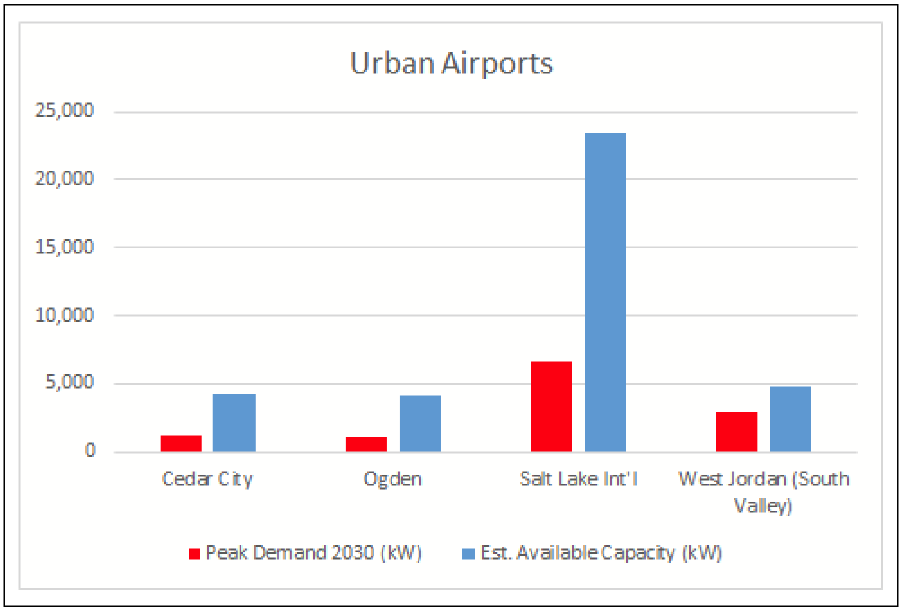

Figure 10. Expected peak demand (2030) and estimated available grid capacity (2022) around urban airports

Figure 10 shows the comparison between expected peak demand and estimated available grid capacity for airports in more densely developed, urban areas. In all cases, the expected peak power demand was lower than the available grid capacity, suggesting that the existing networks could support electrified aviation without additional upgrades. The grid capacity is high because the areas surrounding those airports are well developed with significant existing electrical customers. While the SLC International airport has a significantly higher peak load than the South Valley airport (U42), the demand at U42 represents a larger proportion of the available load compared to SLC. While some airports may have lower peak power demand, they may still represent a significant portion of available capacity.

For example, as shown in Figure 11, at SLC, there is 29,218 kW of nearby installed capacity, with some of that being occupied already, leaving behind an estimated 23,375 kW of unused capacity, which is more than enough to support the estimated maximum demand case electric aviation load of 6,591 kW.

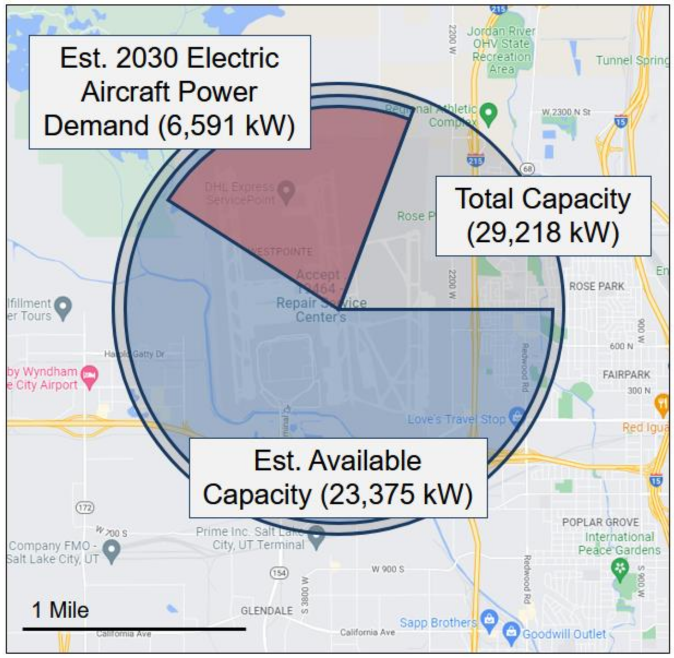

Figure 11. Visualization of the total capacity in a one-mile radius around SLC in 2022, the average portion of that capacity that is available for use in 2022, and an estimated electrified aviation capacity demand for 2030

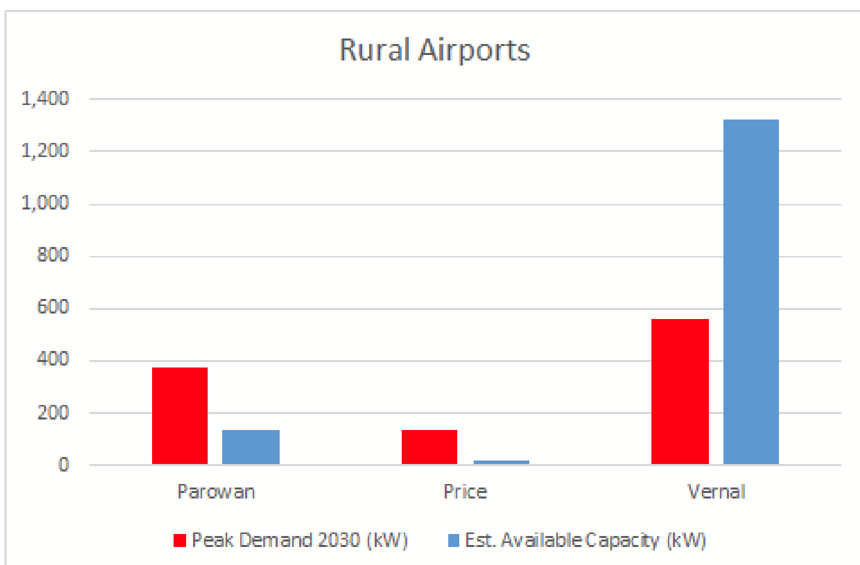

Figure 12. Expected peak demand (2030) and estimated available grid capacity (2022) around rural airports

Figure 12 shows the same comparison for selected rural airports. In this case, some airports' peak demand is greater than the available grid capacity, indicating that grid upgrades will ultimately be necessary. Again, it is important to note the difference between relative capacity and absolute capacity. In this case, Parowan and Price are relatively large loads compared to the network capacity, but in absolute power terms, they are relatively small loads requiring small upgrades, in the range of a few hundred kilowatts.

While Figure 10 and Figure 12 indicate the comparison between expected peak power demand in 2030 and estimated available capacity, it is likely that this available capacity will change, possibly shrinking by 2030. As ground transportation increasingly shifts to electric vehicles, as homes and businesses switch from natural gas to electric heat pumps and given that Utah is the fastest growing state in the nation, load growth on all distribution networks is expected to be significant. Without distribution network capacity upgrades, load growth will diminish the amount of available capacity, possibly necessitating additional upgrades to support aviation electrification.

It is also important to note that while large components of the distribution network such as substations and major distribution lines may not require upgrades for the systems that show adequate total capacity, it is likely that minor upgrades will be needed near the airports. While a substation need not be upgraded to support the airport's power capacity, it is likely that the distribution line connecting the airport to the larger distribution lines leading to the substation will need upgrading, but much of the distribution network can remain unchanged.

2.7 Research Task 5: Proposed Approach for Deploying Electric Aviation Support Infrastructure

2.7.1 Research Task 5: Background and Assumptions

The instantaneous power demand at an airport may fluctuate throughout the day, with higher power demand when several aircraft charge simultaneously and low power demand when few or no aircraft are charging. If the power supplied at the high-demand times could instead be supplied at the low-demand times, the power at all times of day could be brought closer to the average power, which is by definition lower than the peak power.

There are options for reducing the installed power capacity at airports and thereby reduce upfront costs of grid upgrades and monthly peak power demand charges while still providing enough energy to charge electric aircraft. Some potential options are the following:

- A solution that would require minimal hardware investment would be to optimize flight schedules to ensure that as few aircraft as possible charge concurrently, thus delivering the requisite energy without combining to create a large peak. This reduced power need saves on the cost of charger installation and on grid upgrade and peak demand costs. However, in some cases, this may not be possible if many aircraft are trying to quickly charge and depart near the same time.
- Alternatively, battery storage can be used to offset peak power demand by charging at times of low demand. In this case, a battery energy storage system (BESS) will discharge a certain amount of stored power at the time of peak demand and then recharge at times of below-average demand. While the same amount of energy can be supplied to a charging aircraft, the peak power demand has been reduced, thus reducing the peak demand charge on the monthly electricity bill (meaning the monthly energy bill is unchanged).
- Complementarily, a model can be used to determine how on-site solar power can reduce energy costs at the airport and reduce the peak demand charge if peak demand lines up with peak solar generation, an assumption that is effectively weather- and flight-dependent.

2.7.2 Research Task 5: Data Summary

To estimate the monthly costs of electricity, it is necessary to know the electric rate structure an airport would be paying. For similar large commercial or industrial customers in the Rocky Mountain Power service territory, Rate Schedule 6 is common as described in Section 2.6.1. This rate schedule is used to estimate the electrical costs described in this section. The estimated maximum possible power demand and estimated daily energy consumption are necessary for computing a monthly bill, since these are the areas billed by a utility. Additional assumed values required to compute monthly electricity costs are listed in Table 7.

Table 7. Assumed values required to compute monthly electricity costs. PV indicates photovoltaic, or solar, power

Assumed Quantity	Value
Mobile Microgrid Power	1000
Mobile Microgrid Duration (h)	2
Mobile Microgrid Storage Price ($/kWh)	$500.00
Microgrid Lifetime (months)	120
PV Installed Capacity (kW)	1000
PV Summer Capacity Factor	30%
PV Installation Cost ($/kW)	$2,000.00
PV Lifetime (months)	240

To consider the costs of installing equipment like battery storage or solar generation, an estimated price is necessary in each case. At this level of scale, it is assumed that battery storage will cost about $500/kWh of energy storage capacity and that solar power will cost about $2,000/kW of power capacity. These numbers are certainly subject to change in the future, given how massively their costs have declined in the past decade.

To estimate the average energy produced by solar generation, a number known as capacity factor is needed. Capacity factor is the ratio between typical energy production and energy production if the generator always operated at full output. For Utah, solar capacity factor is around 30%.

2.7.3 Research Task 5: SLC Airport Case Study Methodology

While the monthly electricity bill may be reduced by the battery energy storage system, the system itself has an upfront cost of installation. The comparison between cost and benefits of battery storage or solar power can be computed by modeling its impact on the electricity bills and estimating the costs.

Using the estimated peak power demand and the estimated daily energy consumption, a baseline of the total monthly power bills can be estimated following the Rocky Mountain Power rate schedules, in this case Schedule 6. For the case of energy storage, it is assumed that the battery system can provide power during the peak charging time, thus reducing the monthly peak demand, and that the battery is roughly 100% efficient between power input and output. By anticipating future needs when selecting the size of the battery storage, the total cost of the battery can be estimated and amortized over its useful lifetime. Computing the new utility bill with energy storage and the cost of the storage and comparing with the baseline, it is possible to compare the total costs of operation at the airport. A similar method is used to compute the cost of a given solar array and factor its cost into the monthly cost of electricity at the site, comparing the new cost with the baseline costs.

The estimated grid upgrade costs can be computed based on the installed power capacity forecast and substation and transformer upgrade costs described above. Additionally, the distribution line upgrade costs will depend in part on the airport's distance from the substation. The total cost of grid upgrades can be estimated using the formula $Upgrade = P_{EV} \cdot C_{kVA} + d \cdot C_{line}$, where P_{EV} is the installed charging capacity, C_{kVA} is the cost per kilowatt to upgrade the substation and customer transformer, d is the distance between the substation and the airport, and C_{line} is the per-mile cost of upgrading the distribution lines from the substation to the airport.

2.7.4 Research Task 5: SLC Airport Case Study Analysis and Results

For SLC international airport, the installed capacity is forecasted to be significant, so the upgrade costs are expected to be high. Using the cost estimates for grid upgrades provided by RMP, the grid upgrade costs for SLC could range from $1.09M to $2.46M, so there is clear incentive for applying any method to reduce the installed power capacity and therefore the grid upgrade costs. For example, reducing the installed capacity by 1000 kW to 5,591 kW from the originally identified 6,591 kW of installed capacity reduces the install costs to between $0.96M to $2.16M. This does not yet include the monthly electricity bill as explained below.

Under the base case shown in Table 8, the cost of meeting the peak demand represents most of the electricity costs for the airport. Clearly reducing this peak can have a significant impact on reducing the total costs of electricity at the airport.

Table 8. Cost breakdown for the base case

	Price	Cost
Customer Charge	$53.00	$53.00
Facilities	$3.99	$26,298.09
Power	$13.27	$87,462.57
Total Peak	$17.26	$113,760.66
Energy	$0.03888	$10,032.86
Grand Total		$123,846.52
Avg ($/kWh)		$0.4799

Under the assumptions shown in Table 9, the battery energy storage system saves 7.2% off the monthly electricity cost over its lifetime considering the upfront cost of the hardware. This financial model is useful because it shows the cost savings under various battery configurations in terms of power and energy capacity and because it can guide technical needs to achieve certain financial performance. By reducing the energy capacity required or reducing the costs, the total monthly cost of electricity can be further reduced. Setting some target for the cost of electricity will guide the development of future battery energy storage deployments.

Table 9. Cost breakdown with microgrid option

	Price	Cost
Customer Charge	$53.00	$53.00
Facilities	$3.99	$22,308.09
Power	$13.27	$74,192.57
Total Peak	$17.26	$96,500.66
Energy	$0.03888	$10,032.86
Microgrid	Amortized	$8,333.33
Grand Total		$114,919.85
Avg ($/kWh)		$0.4453
Savings (%)		7.2%

Table 10 shows a reduction of 14% compared to the no-solar, no-battery case. Likewise, this model can be used to determine airport-by-airport whether using solar to decrease the electricity costs is worth the upfront costs and can guide the sizing and cost targets of the system. Performance requirements of the solar installation could also be assessed. For example, if the assumption is made that the solar power is only at 50% output during the interval of peak power demand, the cost savings drop to 7%.

Table 10. Cost breakdown with microgrid and solar options

	Price	Cost
Customer Charge	$53.00	$53.00
Facilities	$3.99	$22,308.09
Power	$13.27	$74,192.57
Total Peak	$17.26	$96,500.66
Energy	$0.03888	$1,635.21
Microgrid		$8,333.33
Grand Total		$106,522.20
Avg ($/kWh)		$0.4128
Savings (%)		14.0%

A microgrid solution featuring battery storage and/or solar power also helps with the problem of airports being required to help pay up front for grid upgrade costs when installed charging capacity is large relative to energy consumption. While at low deployments of electrified aircraft the charging power is large compared to the airport's energy consumption, at high levels of deployment the energy consumption costs will cover the requisite portion of the grid upgrade costs. In this case, battery energy storage can be used as a temporary solution to keep the required installed grid power capacity low while aircraft energy demand is low. Once aircraft deployment and energy consumption increases, the battery storage may no longer be necessary as the energy use and resulting bills can cover the requisite portion of the grid upgrade costs. By deferring the need for grid upgrades to a later date, the grid upgrade costs are covered by the airport's electricity bills alone, without the added upfront infrastructure upgrade costs.

2.8 Research Task 6: U-SWEAP Framework

2.8.1 Research Task 6: Background and Assumptions

Electrified aviation proliferation, as evidenced by the analyses of the potential requirements it may leverage on air traffic management and regulation and the electrical grid that are presented in previous sections, is not an event that will occur in isolation. In fact, aviation and its evolving electrified form exist in a broad ecosystem that incorporates the following segments:

- Airports/infrastructure servicing electric aircraft
- The electrical grid that provides power to the airports
- The regulatory agencies that control air/airport traffic and technology certification
- The operators/owners/maintainers of aircraft
- Surface transportation sectors
- The quality of the environment in which the aircraft operate (pollution, noise)
- The local/regional economies in which the aircraft and their operators participate

The U-SWEAP framework is an outline of the most critical of those ecosystem segments and identifies the data gathering activities, analyses, and analysis outputs required to understand the relationship between electrified aviation technology and those ecosystem segments. The framework is intended to be used by UDOT to inform future work in planning the state and agency's response to the advent and proliferation of electrified aviation technologies and operations. Considering these relationships and pursuing the activities outlined in the framework is paramount to understanding the opportunities and constraints inherent to the electric aviation renaissance.

2.8.2 Research Task 6: Data Summary

The U-SWEAP framework is pictured in its entirety in Appendix B and summarized in Figure 13. The framework is divided into three tiers of information, each with blocks of data gathering activities, analyses, and analysis outputs associated with the ecosystem segments described in the previous section.

- **Tier 0 – Electric Aircraft Technology**: this tier addresses the data and analyses that will develop a high-level view of how electrified aviation technologies and development timelines will impact the rest of the ecosystem
- **Tier 1 – Industries/Technologies Directly Affected by Electric Aviation**: this tier addresses the ecosystem segments (Flight Traffic, Operational Total Cost of Ownership, and the Electrical Grid) that could manifest new behaviors, requirements, opportunities, and constraints with the proliferation of electrified aviation technology
- **Tier 2 – Industries/Technologies Indirectly Affected by Electric Aviation**: this tier addresses the ecosystem segments (Flight Traffic, Operational Total Cost of Ownership, and the Electrical Grid) that could manifest new behaviors, requirements, opportunities, and constraints with the proliferation of electrified aviation technology due to the changes wrought by electrified aviation technology on the Tier 1 ecosystem segments.

  **Note: In* Figure 13–Figure 20*, boxes with solid blue shading denote areas addressed directly by the research presented in Sections 2.2 through 2.7, boxes with partial shading denote areas preliminarily addressed by the research presented in Sections 2.2 through 2.7, and boxes with no shading denote areas proposed for future investigation.*

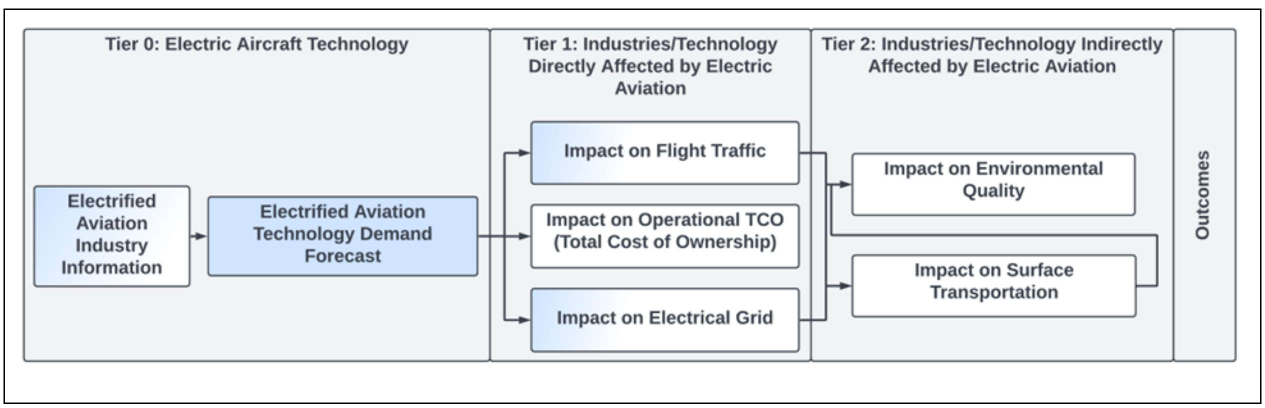

Figure 13. Summary of U-SWEAP Framework (blue shading denotes areas investigated by this work, faded blue shading denotes areas that are preliminarily investigated by this work)

Each block within the framework outlines the data gathering activities or input data that are required to perform a set of forecasts, assessments, and analyses that will produce a set of specific outputs that can be used to characterize the effects of aviation electrification on the ecosystem segment treated by that framework block. Dependencies between input/output data and research activities (forecasts, assessments, and analyses) are identified by dotted lines and solid lines, respectively. Output data from activities in each tier can be used to inform investigations in that tier or higher tiers (e.g., output data from Tier 1 can be used to inform analyses in Tier 1 and Tier 2). In the case of inter-tier information sharing, data relationships are indicated by thick red, solid lines.

The research activities defined in each framework block are defined as follows:

- Analysis: activities that require significant research, data gathering or creation, and numerical investigation and modeling to derive the indicated outputs
- Assessment: activities that require an evaluation based on existing sets of data to derive the indicated outputs
- Forecasts: activities that require the use of existing or derived data to estimate future states for the analysis subject(s)

Additionally, this work identifies a number of outcomes that could develop if the framework is exercised. The outcomes include opportunities for Utah to become a national and world leader in electrified aviation, the identification of potential considerations in developing business cases centered on electrified aviation technology, and the realization of techno-economic synergies within the ecosystem.

2.8.3 Research Task 6: Framework Development and Overview

2.8.3.1 Tier 0: Electric Aircraft Technology

This framework section outlines the data gathering activities, analyses, and analysis outputs for each block representing the ecosystem segments addressed by the framework. The data in this category that is relevant to the analyses conducted as part of this work is represented in the forecasts for flight schools, thin haul/commercial, and AAM presented in Sections 2.2, 2.3, and 2.4 and in the tables presented in APPENDIX A: STATEWIDE ELECTRIFICATION FORECAST.

Electrified Aviation Industry Information: data addressing the development and deployment of electrified aircraft, the operational and cost parameters of those aircraft, and the state of certification and regulation for the industry (Figure 14).

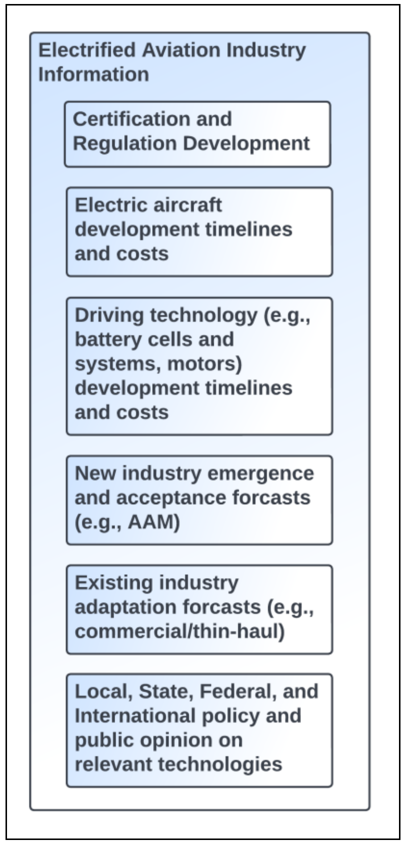

Figure 14. Tier 0: Electrified Aviation Industry Information Framework Block

Electrified Aviation Technology Demand Forecast: data and research activities addressing the deployment and operation of electric aircraft and the demands that they exert on the electrical grid. This forecast is the main body of work presented in this work and represented in Sections 2.2 through 2.7 (Figure 15).

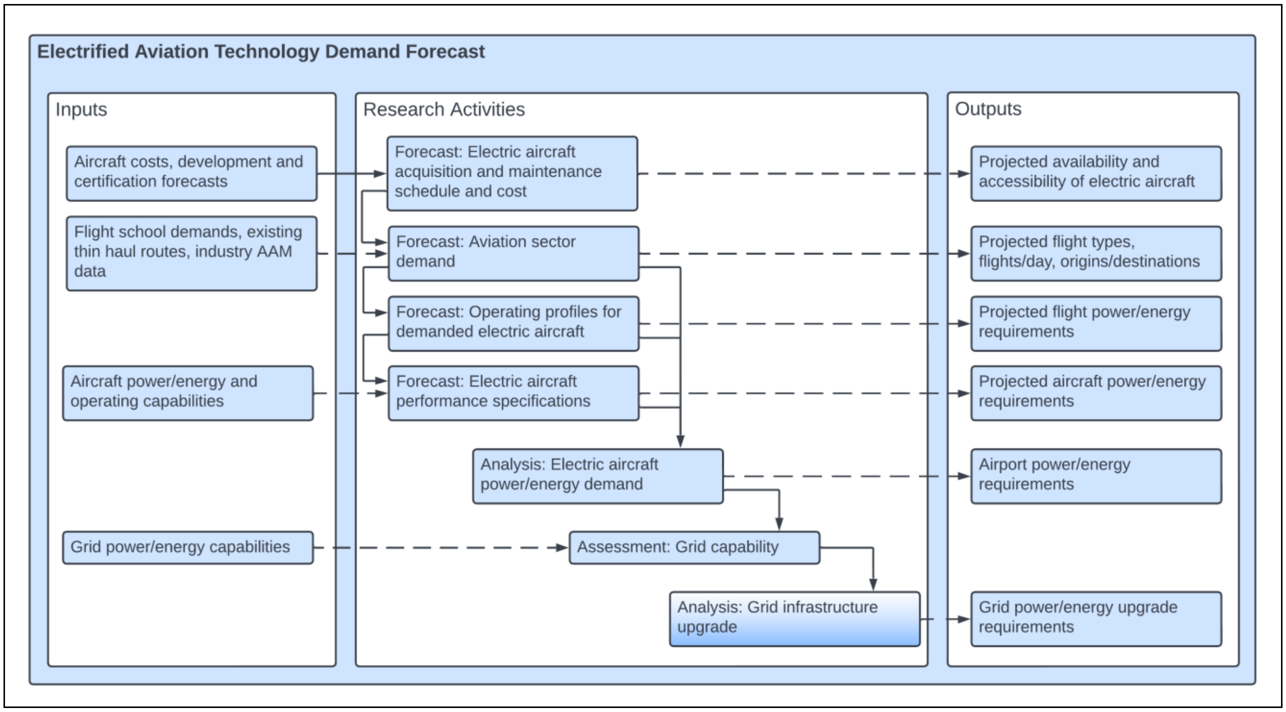

Figure 15. Tier 0: Electrified Aviation Technology Demand Forecast Framework Block

2.8.3.2 Tier 1: Industries/Technology Directly Affected by Electric Aviation

Impact on Flight Traffic: data and research activities addressing the effects of aviation electrification on flight traffic in the following areas (Figure 16):

- Statewide aircraft fleet demographics
  - Percentage electric vs. traditional fuel
  - Replacement rate of traditional fuel aircraft by electric aircraft
- Air traffic along air routes and at airports (addressed in Section 2.5.3)
- Airspace and airport regulation

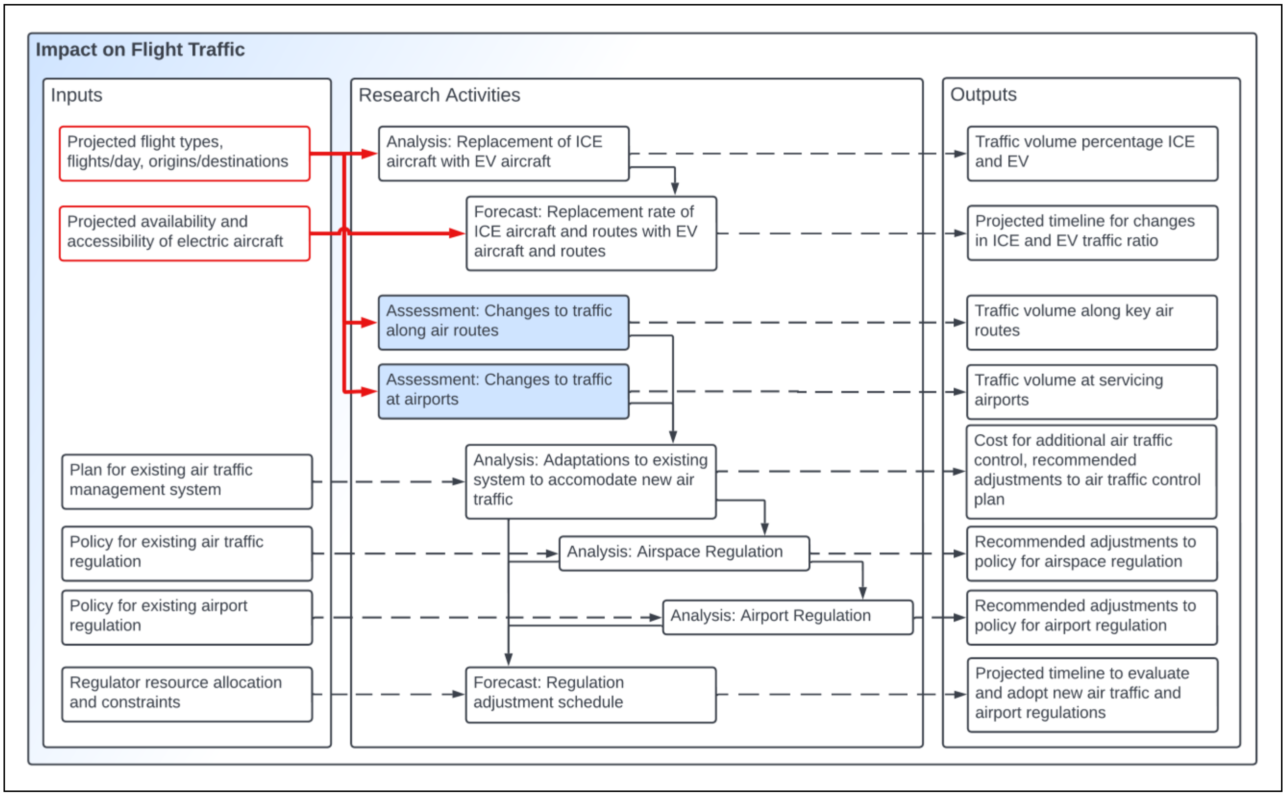

Figure 16. Tier 1: Impact of Flight Traffic Framework Block

Inputs from Tier 0 blocks used in Impact on Flight Traffic research activities:

- "Projected flight types, flights/day, origins/destinations" from the Electrified Aviation Technology Demand Forecast will inform:
  - Analysis: Replacement of fueled aircraft with electric aircraft
  - Assessment: Changes to traffic along air routes
  - Assessment: Changes to traffic at airports
- "Projected availability and accessibility of electric aircraft" from the Electrified Aviation Technology Demand Forecast will inform:
  - Forecast: Replacement rate of fueled aircraft and routes with electric aircraft and routes

Impact on Operational Total Cost of Ownership (TCO): data and research activities addressing the impact of aircraft electrification on the operational TCO for aircraft owners and operators in the following areas (Figure 17):

- Aircraft acquisition
- Energy (i.e., fuel) costs
- Maintenance costs

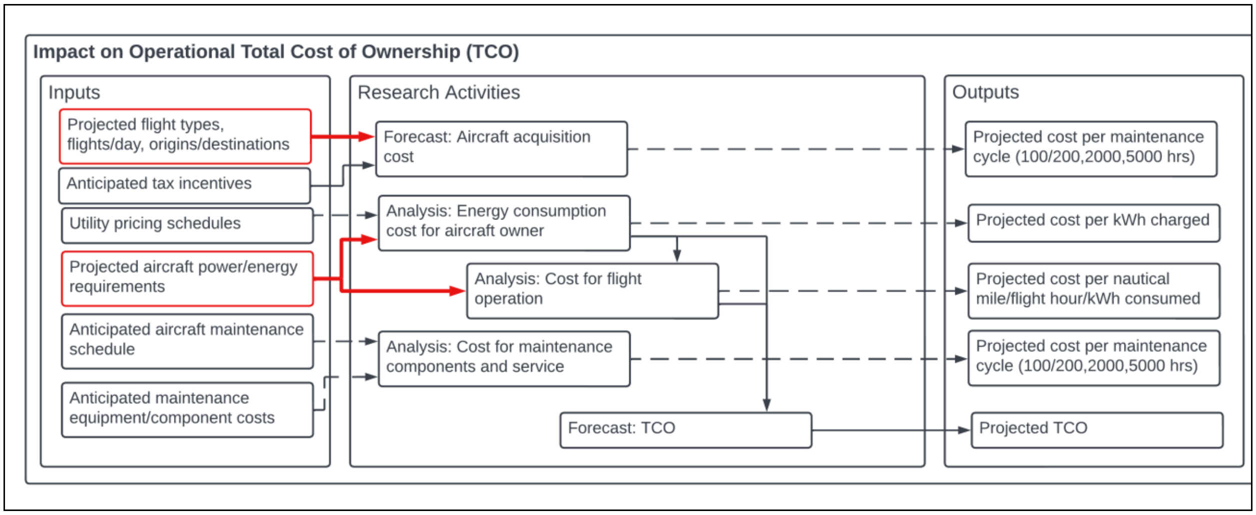

Figure 17. Tier 1: Impact on Operational Total Cost of Ownership (TCO) Framework Block

Inputs from Tier 0 blocks used in Impact on Operational Total Cost of Ownership (TCO) research activities:

- "Projected flight types, flights/day, origins/destinations" from the Electrified Aviation Technology Demand Forecast will inform:
    - Forecast: Aircraft acquisition cost
- "Projected aircraft power/energy requirements" from the Electrified Aviation Technology Demand Forecast will inform:
    - Analysis: Energy consumption costs for aircraft owner
    - Analysis: Cost for flight operation

Impact on Electrical Grid: data and research activities addressing the impact of aircraft electrification on the operations and development of electrical grid infrastructure in the following areas (Figure 18):

- Grid usage rates and patterns

- Grid capability
- Cost to develop new grid capabilities to accommodate new demands from electrified aviation
- Grid operational models
- Charging infrastructure development
- Economic opportunities in grid development

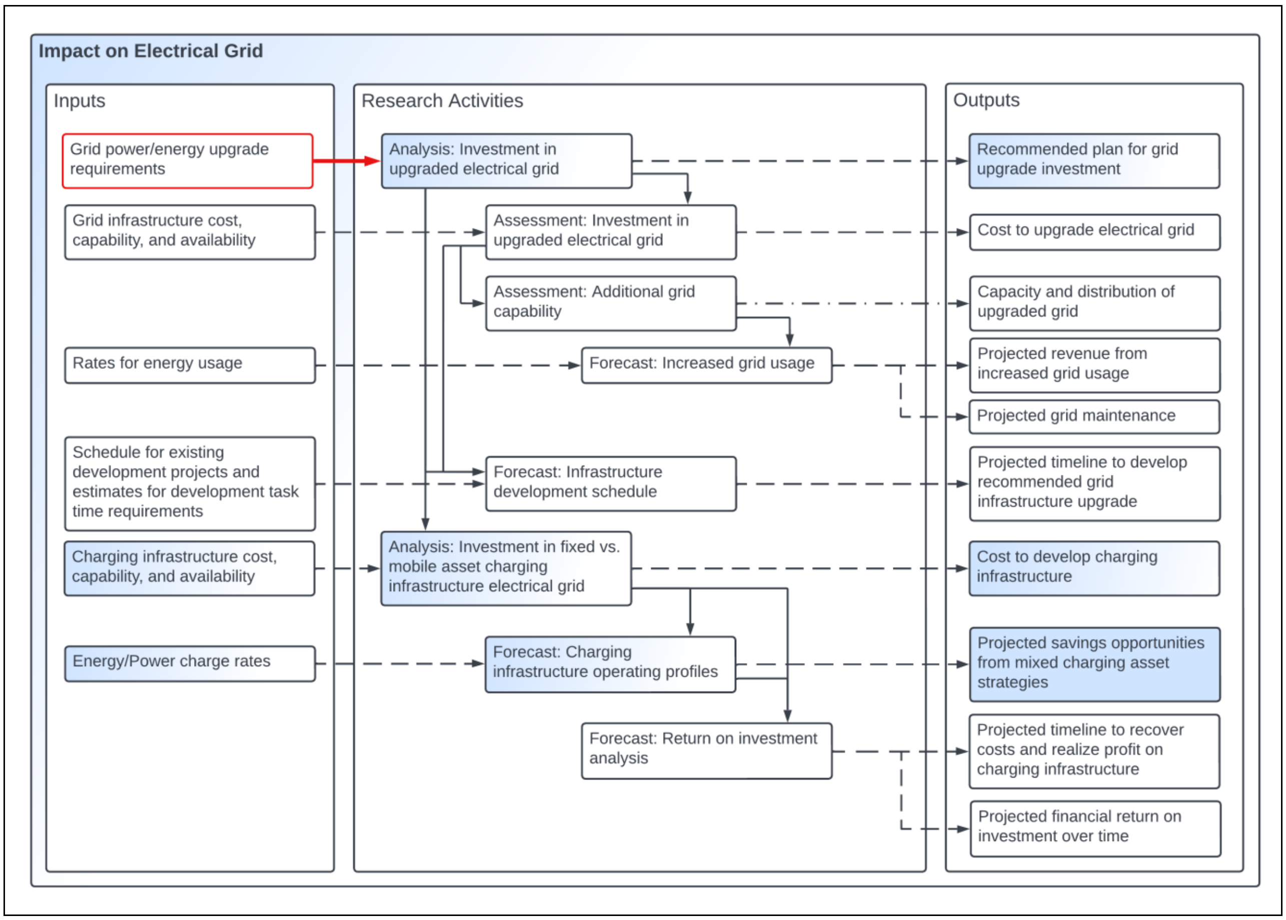

Figure 18. Tier 1: Impact on Electrical Grid Framework Block

Inputs from Tier 0 blocks used in Impact on Electrical Grid research activities:

- "Grid power/energy upgrade requirements" from the Electrified Aviation Technology Demand Forecast will inform:
    - Analysis: Investment in upgraded electrical grid

2.8.3.3 Tier 2: Industries/Technology Indirectly Affected by Electric Aviation

Impact on Environmental Quality: data and research activities addressing the impact of aircraft electrification on environmental quality in the following areas (Figure 19):

- Criteria and carbon emissions
  - Emitted by air and surface transportation affected by electrified aviation
  - Emitted by point sources servicing electrified aviation
- Costs associated with achieving emissions reduction targets
- Timeline associated with achieving emissions reduction targets
- Human health benefits from achieving emissions reduction targets

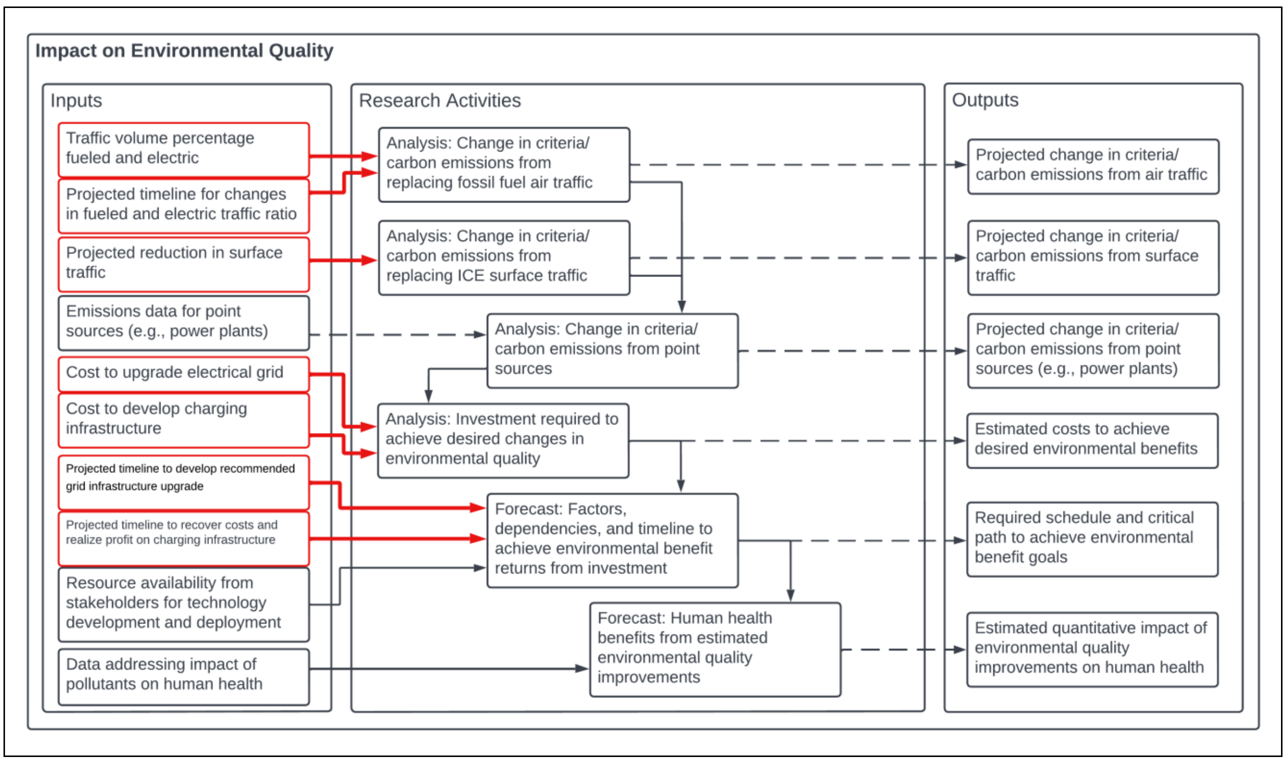

Figure 19. Tier 2: Impact on Environmental Quality Framework Block

Inputs from Tier 1 blocks used in Impact on Environmental Quality research activities:

- "Traffic volume percentage fueled and electric" from Impact on Flight Traffic will inform:
  - Analysis: Change in criteria/carbon emissions from replacing fossil fuel air traffic

- “Projected timeline for changes in fueled and electric traffic ratio” from Impact on Flight Traffic will inform:
    - Analysis: Change in criteria/carbon emissions from replacing fossil fuel air traffic
- “Cost to upgrade electrical grid” from Impact on Electrical Grid will inform:
    - Analysis: Investment required to achieve desired changes in environmental quality
- “Cost to develop charging infrastructure” from Impact on Electrical Grid will inform:
    - Analysis: Investment required to achieve desired changes in environmental quality
- “Projected timeline to develop recommended grid infrastructure upgrade” from Impact on Electrical Grid will inform:
    - Forecast: Factors, dependencies, and timeline to achieve environmental benefit returns from investment
- “Projected timeline to recover costs and realize profit on charging infrastructure” from Impact on Electrical Grid will inform:
    - Forecast: Factors, dependencies, and timeline to achieve environmental benefit returns from investment

Inputs from Tier 2 blocks used in Impact on Environmental Quality research activities:

- “Projected reduction in surface traffic” from the Impact on Surface Transportation will inform:
    - Analysis: Change in criteria/carbon emissions from replacing ICE surface traffic

Impact on Surface Transportation: data and research activities addressing the impact of aircraft electrification on surface transportation in the following areas (Figure 20):

- Surface traffic volume
- Surface transportation infrastructure development and maintenance costs and schedules
- Surface EV traffic infrastructure development cost and schedule
- Grid usage by surface EV traffic

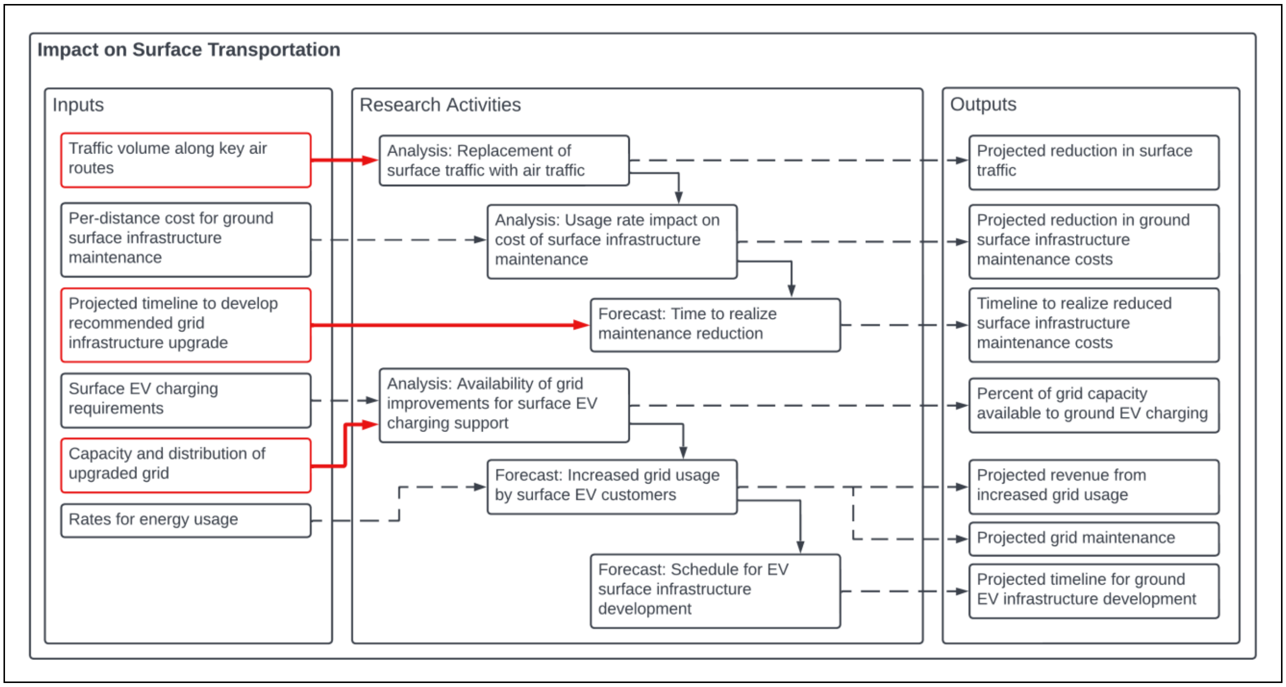

Figure 20. Tier 2: Impact on Surface Transportation Framework Block

Inputs from Tier 1 blocks used in Impact on Surface Transportation research activities:

- “Traffic volume along key air routes” from Impact on Flight Traffic will inform:
  - Analysis: Replacement of surface traffic with air traffic
- “Projected timeline to develop recommended grid infrastructure upgrade” from Impact on Electrical Grid will inform:
  - Forecast: Time to realize maintenance reduction
- “Capacity and distribution of upgraded grid” from Impact on Electrical Grid will inform:
  - Analysis: Availability of grid improvements for surface EV charging support

<u>2.8.4 Research Task 6: Framework Outcomes</u>

2.8.4.1 Global Outcomes

If exercised with the intent to create an actionable plan to prepare for and facilitate statewide aviation electrification, the framework can result in the following outcomes.

1. Establishment of Utah in an internationally recognized leadership position in electric aviation technology and a hub for the development, manufacturing, and deployment of clean, sustainable, accessible transportation
2. Development of the knowledge required to plan for and invest in a future in which Utah's industry and people can enjoy the economic, energy, social, transportation, and environmental benefits of electrified flight
3. Identification of potential techno-socio-economic synergies within the electrified aviation ecosystem*
4. Identification of key potential stakeholders, anticipated economic returns, and ownership models in the electrified aviation ecosystem*

   **Note: Outcomes 3 and 4 are discussed in greater detail in the following sections.*

2.8.4.2 Opportunities for Techno-Socio-Economic Synergies

As evidenced by the data dependencies (red boxes and arrows) between each framework tier and block that are discussed in Section 2.8.3 and Figure 16 through Figure 20, the interaction between segments of the electrified aviation ecosystem is substantial. By using the U-SWEAP framework to understand a plan for the advent and future proliferation of electrified aviation technology, UDOT and Utah are afforded the opportunity to identify and capitalize on synergies between required changes to the various ecosystem segments. The framework outline discussed in the previous section identifies several of these opportunities, which are outlined below. Exercising the framework will undoubtedly reveal additional opportunities for efficiency in planning and facilitating the development and regulation of the new electrified aviation ecosystem in the State of Utah.

- Projecting the adoption rate, use cases, and energy consumption rates for electrified aviation allows the state to develop a plan to regulate and tax electrified aviation operations effectively and fairly relative to existing aviation operations
- Projecting energy/power requirements at rural airports allows the state to facilitate the development of non-conventional (e.g., mobile microgrid) infrastructure development to offset the relatively low grid capability in those areas and bring the advantages and accessibility of electrified aviation to rural and at-risk populations that do not

traditionally experience the same benefits from new transportation technologies that urban populations experience

- Projecting the likely hub locations for AAM operations allows the state to plan ahead to facilitate the development of other industries in those areas (e.g., emergency services, commercial or business districts, surface public transportation connections)
- Developing an understanding of the operational TCO for electric aircraft owners and operators allows the state the data required to consider incentive programs for private and corporate entities wishing to contribute to the state's economy using electrified aircraft technology
- Upgrades to the electrical grid at and around airports that will support electrified aviation operations may also be used to facilitate the development of charging infrastructure that supports electric ground vehicle operations. Pairing the electrified-aviation-driven electrical grid requirements with similar requirements driven by the burgeoning electric ground vehicle industry provides insight into opportunities to develop multi-use infrastructure that can service both industries efficiently and at lower cost.
- Understanding the effect of an increase in electrified aircraft operations as an alternative transportation model to traditional surface transportation methods on ground traffic volumes and concentrations provides information to plan for:
    - Changes to surface traffic brought on by the advent of electrified aviation operations
    - Future infrastructure development projects (e.g., highways, commercial centers, public transportation options)
    - Changes in the location, volume, and composition of transportation emissions in the state

2.8.4.3 Business Case Considerations

The plethora of analysis inputs, research, and outputs provided in the framework and the list of techno-socio-economic synergies described in the previous section alludes in multiple instances to business-oriented opportunities. This section outlines some of those opportunities in the context of three critical categories of information used to drive a business case:

1. Cost and Investment
2. Ownership Models
3. Anticipated Returns

Cost and Investment: Cost and investment categories consider how capital is engaged with electrified aviation technologies or technology-adjacent infrastructure to enable its use in commercial ventures. Note that the investment considerations presented herein do not determine who or what type of organization is making the investments. A formal business case analysis as informed by these framework considerations will need to weigh needed investments relative to multiple factors, including potential returns, to best determine if "investors" are private entities solely, private entities with the help of public incentives, public entities (with potential to maintain ownership or effect future public divestment), public/private partnerships, or any combination of the above depending on use case and location.

- <u>Electric aircraft/fleet acquisition</u>—flight schools and/or private companies will require investment to purchase new electric aircraft or retrofit/upgrade existing aircraft
- <u>Electric aircraft/fleet operation and maintenance</u>—as electric aircraft fleets are introduced, aviation maintenance professionals (AMP) will need to be trained on and hired for electric aircraft operations and maintenance (O&M). Costs include technicians' labor and equipment, and eventually replacement batteries.
- <u>Charging equipment installation</u>—while most existing airport equipment, such as hangars and runways, will be equally as compatible with electric aircraft as it is with existing aircraft, airports will need to consider some specific upgrades to prepare for electric aircraft. One major investment is the installation of charging equipment (electric vehicle service equipment – EVSE) to "refuel" electric aircraft since airports are generally not equipped with EVSE in the flight operations areas. In some cases, the aircraft can come to the EVSE in hangers or at other convenient locations on the flight side; however, charging will also need to be taken to the aircraft in some use cases, including where grid infrastructure at a facility is lacking or when the need to charge quickly on the tarmac is integral to fleet operations (e.g., flight schools).
- <u>Charging equipment operation and maintenance</u>—just as with electric aircraft, costs will be incurred for charging equipment O&M once equipment is installed at airports.

- Grid infrastructure upgrade—as deployment of electric aircraft advances, utilities must be able to support the energy demands of charging aircraft. While most municipal and private utilities have sufficient capacity to supply electricity to airports in Utah for the next 5-10 years relative to growing electric aircraft adoption, there will eventually be a need for infrastructure scaling and upgrades to provide sufficient amounts of energy to statewide airports.

Ownership Models: Ownership models consider how electric aircraft and electrified aircraft supporting infrastructure are owned and operated.

- Private aircraft ownership—private individuals owning and operating their own aircraft or small fleet of aircraft
- Commercial aircraft ownership—business entities owning and operating their own aircraft or small fleet of aircraft
- Commercial fleet ownership—business entities owning and operating fleets of aircraft in a profit-oriented model
- University/flight school fleet ownership—universities or business entities operating fleets of aircraft in a pilot training model
- Privately owned infrastructure—private individuals owning and operating their own electrified aviation supporting infrastructure
- Commercially owned infrastructure—business entities owning and operating their own electrified aviation supporting infrastructure or operating that infrastructure in a profit-oriented model
- Publicly owned infrastructure—public entities owning and operating their own electrified aviation supporting infrastructure or operating that infrastructure in a service- or profit-oriented model

Anticipated Returns: Anticipated returns encompass the economic (financial, opportunity growth, population growth, etc.) and social opportunities driven by investment in electrified aviation technology.

- Electric aircraft/fleets operation and maintenance—initial O&M costs at the emerging industry stage may be comparable to traditional AMP work but, over time, the total cost of ownership for electric aircraft is anticipated to be nearly 50% lower than traditional aircraft.

- Utility expansion/charging revenues—expansion of grid accessibility and capacity as well as charging infrastructure (both fixed and mobile) may produce opportunities for infrastructure multi-utility, increasing the ratio of revenue-to-investment, improving profit opportunity
- Job creation in the aviation and utility sectors—all anticipated investments will lead to job creation and positive economic impacts in sectors including aircraft design and manufacturing, aircraft retrofit and maintenance, battery design and manufacturing, infrastructure scaling, flight school instruction, aviation maintenance programs, construction, academic research, and other service industries
- Flight school enrollment expansion statewide—as Utah flight schools adopt electric fleets, flight training and aviation maintenance students will be attracted to enrollment at Utah schools adopting these innovative technologies. As such, enrollment in flight schools using electric aircraft will likely increase, resulting in greater funding and enrollment opportunities for the state's universities and private flight schools.
- Social mobility and opportunity accessibility—electric AAM and thin-haul/commercial routes will enable more equitable population dispersion and economic benefits statewide, including new transportation opportunities for rural and at-risk communities. Commuting via electric aircraft will enable Utah residents to continue working in the city while living in less densely populated areas. That trend can stimulate growth in the economies of more remote communities and relieve traffic and air quality concerns in the most densely populated areas statewide. Conversely, providing fast, long-distance transportation to urban populations may reduce the need for personally owned transport in cities, further reducing traffic congestion and urban distributed emissions.
- Environmental health opportunities—synergizing efforts to mitigate air quality issues through electrifying freight transport and commuter rail, and electrified aviation through shared grid and charging infrastructure will further add to the positive environmental impacts
- Industry leadership gravity-well opportunities—as Utah continues to lead in electric aviation innovation, additional investment will flow to Utah-based companies, and other

companies working in the space will select Utah for relocating or expanding ventures to Utah where the electric aviation sector is booming

- R&D/technology innovation—as Utah becomes a leader in the electric aviation innovation space, new and improved technologies will emerge from Utah companies and universities, continuing to make Utah attractive to potential researchers, investors, and innovators

3.0 CONCLUSIONS

3.1 Summary

The advent and proliferation of electrified aviation technology and operations is imminent. The state of Utah recognizes the potential advantages of preemptively exploring and planning for a future in which its airports and transportation ecosystem will both need to adapt to new modes of aviation operation and have the opportunity to evolve and thrive through that adaptation. To that end, this work provides an exploration forecasting the development of electrified operations in flight school, thin haul/commercial, and AAM segments in the state's aviation ecosystem. It takes those forecasts, together with additional analysis examining their requirements on grid capability at airports and an examination of grid and charging infrastructure, and maps the research activities required to understand the impact of electrifying aviation on the statewide aviation ecosystem.

The U-SWEAP framework and supporting research presented in this work are intended to guide UDOT and the state of Utah's approach to preparing for, facilitating, and thriving because of the advent and proliferation of electrified aviation. The U-SWEAP framework and its described outcomes provide a vision and vehicle through which the economic, behavioral, and material impacts of electrified aviation on other segments in its ecosystem may be explored and quantified.

The exploratory work completed in forecasting the electrification of flight school, thin haul/commercial, and AAM operations in the state provides a unique and detailed view into the requirements, challenges, and opportunities presented by electrified aviation technology. Specifically, these investigations illuminate the timelines over which electric aircraft and infrastructure may become available, the volumes in which they may be deployed, and the requirements they will leverage on existing air traffic management and electrical grid infrastructure. Preeminent among those requirements, this work explores the new demands that electrified aircraft operations will leverage on the electrical grid at and around airports in both urban and rural settings and provides an example of how fixed- and mobile-asset charging infrastructure could be functionally and financially implemented at a major airport.

3.2 Findings

Following is a summary of the findings from each of the six research tasks that comprise this work.

<u>3.2.1 Task 1</u>

The following points summarize the observations resulting from the development of the flight school forecast.

- Flight schools will likely be the first aviation segment to electrify in Utah due to how well typical flight school operations accommodate the capability set of early electric aircraft
- Flight school electrified operations will drive the majority of energy consumption at airports that act as the center of operations for flight schools (e.g., Logan, Provo, Cedar City)
- The infrastructure developed for flight school electrified operations will be foundational to the early implementation of electrified aircraft in the thin haul/commercial and AAM aviation segments

<u>3.2.2 Task 2</u>

The following points summarize the observations resulting from the development of the thin-haul/commercial forecast.

- Electric aircraft capable of filling thin-haul/commercial roles will likely enter the market later than electric training aircraft
- The primary roles of electrified thin-haul/commercial aircraft will be to replace existing commuter and cargo routes in the state

- Electrified thin-haul/commercial operations can initially use electric infrastructure developed to support flight schools and then drive the development of their own dedicated infrastructure as the industry segment matures
- Thin-haul/commercial operations will likely be focused around the two cardinal axes in the state

3.2.3 Task 3

The following points summarize the observations resulting from the development of the AAM forecast.

- The proposed AAM adoption and operational scenarios presented in the forecast are forward-looking and based on the timelines for development and availability of segment-leading EVTOL developers and manufacturers
- AAM operations in Utah may initially target hubs with easy access to critical services and amenities that are associated with a culture that values convenience, accessibility, and novelty over cost savings
- In the next decade, AAM proliferation along the Wasatch Front (and in other urban areas) may develop an operational pattern focused on short “hops” between key population, commercial, business, and tourism centers with fast refueling times and minimized non-operational time
- Most potential locations of AAM hub development are not far enough apart to require high-energy capacity vehicles

3.2.4 Task 4

The infrastructure capabilities and requirements for electrified aviation across Utah share the following characteristics.

- The worst-case power consumption may necessitate major upgrades to power grid infrastructure, with this varying significantly by airport
- Peak power costs paid to the electric utility may represent the majority of the total cost of electricity for electrified aviation, with the energy costs being a much smaller proportion

- Urban airports are typically surrounded by well-developed power distribution networks that should have more than enough available capacity to support even large aviation power demands. Conversely, rural airports do not have well-developed power grids, and would likely need relatively major upgrades despite having much smaller power demand.
- Aviation electrification is an additional load that is expected to be added to the grid in the near future, along with ground vehicle electrification, heat pumps, and natural population growth. As a result, grid capacity available today may be more strained as real-world deployment of electrified aviation develops.

3.2.5 Task 5

There are multiple solutions to reducing the total cost of deploying chargers for electrified aviation at airports, including.

- Smarter management of charging times to allow aircraft to share charging equipment and grid infrastructure,
- Battery energy storage to draw power from the grid at times of low demand and release at times of high demand to reduce peak demand costs while keeping energy consumption unchanged, and
- Solar generation at the airports if power demand is expected to be high at times of day and seasons of the year when the sun is at its greatest energy-producing potential.

3.2.6 Task 6

The following are the primary projected outcomes for exercising the U-SWEAP framework.

- Establishment of Utah in an internationally recognized leadership position in electric aviation technology and a hub for the development, manufacturing, and deployment of clean, sustainable, accessible transportation
- Development of the knowledge required to plan for and invest in a future in which Utah's industry and people can enjoy the economic, energy, social, transportation, and environmental benefits of electrified flight

- Identification of potential techno-socio-economic synergies within the electrified aviation ecosystem*
- Identification of key potential stakeholders, anticipated economic returns, and ownership models in the electrified aviation ecosystem

3.3 Limitations and Challenges

The U-SWEAP framework and supporting analysis presented in this work are exploratory in nature—they are intended to aid the State of Utah in gathering the information required to develop a plan to address the advent and proliferation of electrified aviation. The primary objective of the analyses conducted in this work was to support the development of the U-SWEAP framework and provide a qualitative representation of how aviation electrification might develop in the state over the next decade in several key aviation industry segments. They are not intended as exhaustive examinations of those segments, however.

4.0 RECOMMENDATIONS FOR IMPLEMENTATION

To capitalize on the U-SWEAP framework and the analyses conducted in this work, it is recommended that the state develop a plan to conduct the analyses outlined in each of the framework sections. Generally, the following prioritization of tasks is recommended:

- As needed, broader application of the analyses conducted at the Tier 0 framework level in the scope of this work. This work could be accomplished as either one large or a set of several smaller projects focused on the forecasts for the different aviation segments (e.g., flight schools, thin haul/commercial, AAM, or others like drone cargo delivery and emergency services).

- As needed, broader application and development of the analyses conducted at the Tier 1 framework level in the scope of this work. This work could be accomplished as two UTRAC-level projects, one each for the Impact on Flight Traffic and the Impact on Grid Infrastructure activities. The project focused on Impact on Grid Infrastructure should take the following emphasis.

    - Identify options for reducing upfront and monthly electricity costs: As the cost to upgrade distribution grids to meet high installed charging capacity and the subsequent monthly costs are expected to be significant, it is recommended that airports identify planning and technical solutions to reduce this need. The simplest method is to plan flight schedules to limit the number of aircraft attempting to charge simultaneously. This will reduce costs at the airport by reducing the number of chargers, reduce costs to upgrade grid infrastructure, and reduce the monthly costs paid by the airport. Similarly, energy storage and on-site generation can help reduce the grid upgrade costs and the monthly power and energy costs, all while providing the requisite level of service for aviation electrification.

- Development of the research activities discussed in the Tier 1 framework level in the following order of priority. This order of priority allows the state to begin work on creating a plan to address what is likely the highest cost and most time intensive set of impacts, those on the electrical grid, as early as possible. This work should be accomplished as three separate projects of considerable depth and funding, as these three analyses will develop the bulk of the information required to develop a near-term plan for statewide aviation electrification.

1. Impact on Grid Infrastructure
2. Impact on Flight Traffic
3. Impact on Total Cost of Ownership (TCO)

- Development of the research activities discussed in the Tier 2 framework level. These activities could take the form of individual projects or could be included in Tier 1 framework level projects as complementary or system-level analyses.
    - The research activities outlined in the Impact on Environmental Quality and Impact on Surface Transportation framework blocks may be more conveniently conducted as needed during the Tier 1 framework level activities to augment or provide context to those activities

REFERENCES

Presented in order or use in the report.

1. Diamond Aircraft announces future All-Electric Trainer and partnership with Electric Power Systems. (n.d.). Www.diamondaircraft.com. Retrieved May 20, 2022, from https://www.diamondaircraft.com/en/about-diamond/newsroom/news/article/diamond-aircraft-announces-future-all-electric-trainer-and-partnership-with-electric-power-systems/
2. Electric Aircraft. (n.d.). Www.diamondaircraft.com. https://www.diamondaircraft.com/en/service/electric-aircraft/
3. eFlyer | Innovation for the Next Generation. (n.d.). Retrieved May 20, 2022, from https://electricflyer.com/
4. eFlyer - Bye Aerospace. (2019, May 9). https://byeaerospace.com/electric-airplane/
5. Fleet Facilities | Aviation | Utah Valley University. (n.d.). Www.uvu.edu. https://www.uvu.edu/aviation/about/fleet.html
6. Grimme, Wolfgang & Paul, Annika & Peter, Fabian & Atanasov, Georgi & Wensveen, Jasper. (2019). Evaluation of the Market Potential and Technical Requirements for Thin-Haul Air Transport. 10.25967/490206.
7. Aeroplex Group Partners, LLC (2020). Balance Utah Feasibility Study for a Daily Flight from Vernal, UT to Salt Lake City, UT and/or Provo, UT.
8. Marien, T. V., Antcliff, K. R., Guynn, M. D., Wells, D. P., Schneider, S. J., Tong, M., Trani, A. A., Hinze, N. K., & Dollyhigh, S. M. (2018). Short-Haul Revitalization Study Final Report. Ntrs.nasa.gov. https://ntrs.nasa.gov/citations/20180004393
9. Zhang, Q. (n.d.). Air s.Pace Non-Confidential ELectric Innovative Commuter Aircraft D2.1 Economic Feasibility Study for a 19 PAX Hybrid-Electric Commuter Aircraft. https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/innovation/elica-d2-1-economic-feasibility-study-for-a-19-pax-hybrid-electric-commuter-aircraft.pdf
10. Tecnam Launches P-Volt Transition with the P2012 Traveller. (2021, November 16). Tecnam Aircraft. https://www.tecnam.com/tecnam-aircraft-launches-the-p-volt-transition-program-to-help-p2012-traveller-owners-position-themselves-for-the-green-future-of-aviation/
11. Justin, Cedric & Payan, Alexia & Briceno, Simon & Mavris, Dimitri. (2017). Operational and Economic Feasibility of Electric Thin Haul Transportation. 10.2514/6.2017-3283.
12. Alpine Air Express | United States. (n.d.). Alpine Air Express. Retrieved May 20, 2022, from https://www.alpine-air.com/
13. Weit, Colby & Justin, Cedric & Mavris, Dimitri. (2019). Network-Optimized Design of a Notional Hybrid Electric Airplane for Thin-Haul Operations. 10.2514/6.2019-3002.

14. Ampaire powers up hybrid electric Eco Caravan aircraft for first time. (2022, April 25). Aerospace Testing International. https://www.aerospacetestinginternational.com/news/electric-hybrid/ampaire-powers-up-hybrid-electric-eco-caravan-aircraft-for-first-time.html

15. FlightAware - Flight Tracker / Flight Status / Flight Tracking. (2016). FlightAware. https://flightaware.com/

16. Uber Elevate White Paper (Oct 2016). (n.d.). Evtol.news. https://evtol.news/news/uber-elevate-white-paper-oct-2016

17. Says, D. (n.d.). Morgan Stanley shifts its timeline but stays bullish on eVTOL market. Evtol.com. Retrieved May 20, 2022, from https://evtol.com/news/morgan-stanley-shifts-timeline-stays-bullish-evtol-urban-air-mobility/

18. Bogaisky, J. (n.d.). Has Joby Cracked The Power Problem To Make Electric Air Taxis Work? Forbes. Retrieved May 20, 2022, from https://www.forbes.com/sites/jeremybogaisky/2020/11/23/joby-batteries-electric-aviation/?sh=bc0b54c76a73

19. Hawkins, A. J. (2021, June 11). Air taxi startup Archer shows off small electric aircraft but no flight test. The Verge. https://www.theverge.com/2021/6/11/22529534/archer-maker-air-taxi-evtol-reveal-specs

20. Archer (Unnamed five seat eVTOL). (n.d.). Evtol.news. Retrieved May 20, 2022, from https://evtol.news/archer/#:~:text=Range:%2060%20miles%20(nearly%20100

21. VX4 | Urban Air Mobility. (n.d.). Vertical Aerospace. Retrieved May 20, 2022, from https://vertical-aerospace.com/vx4/

22. A look at Eve's eVTOL aircraft as it targets type certification in late 2025. (n.d.). Evtol.com. Retrieved May 20, 2022, from https://evtol.com/features/eve-evtol-aircraft-design-approach/

23. What we know about Lilium's eVTOL batteries so far. (n.d.). Evtol.com. https://evtol.com/features/lilium-evtol-batteries-what-we-know/

24. Airbus' return to the eVTOL air taxi is a bit of a head-scratcher. (2021, September 22). New Atlas. https://newatlas.com/aircraft/airbus-cityairbus-evtol-air-taxi/

25. Airbus reveals the next generation of CityAirbus | Airbus. (n.d.). Www.airbus.com. https://www.airbus.com/en/newsroom/press-releases/2021-09-airbus-reveals-the-next-generation-of-cityairbus

26. 14 CFR § 91.151 - Fuel requirements for flight in VFR conditions. (n.d.). LII / Legal Information Institute. Retrieved May 20, 2022, from https://www.law.cornell.edu/cfr/text/14/91.151

27. Traffic Statistics. (n.d.). UDOT. https://www.udot.utah.gov/connect/business/traffic-data/traffic-statistics/

28. Rocky Mountain Power. (2022). Rocky Mountain Power—State of Utah Price Summary. https://www.rockymountainpower.net/content/dam/pcorp/documents/en/rockymountainpower/rates-regulation/utah/Utah_Price_Summary.pdf

29. Person, and Allison Lampert. "United Airlines to Buy 100, 19-Seat Electric Planes from Heart Aerospace." *Reuters*, Thomson Reuters, 13 July 2021, https://www.reuters.com/business/sustainable-business/united-airlines-buy-100-19-seat-electric-planes-heart-aerospace-2021-07-13/.
30. ENR 1.4 ATS Airspace Classification. (n.d.). Retrieved July 1, 2022, from https://www.faa.gov/air_traffic/publications/atpubs/aip_html/part2_enr_section_1.4.html
31. *Handbooks & Manuals*. Handbooks & Manuals | Federal Aviation Administration. (n.d.). Retrieved July 1, 2022, from https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/17_phak_ch15.pdf

APPENDIX A: STATEWIDE ELECTRIFICATION FORECAST

Appendix A provides the raw data generated during Research Tasks 1-3, beginning with the forecasts for electrification of the flight school (Section A.1 Flight School Forecast), thin haul/commercial (Section A.2 Thin-Haul/Commercial Forecast), and AAM (Section A.3 AAM Forecast) aviation industry segments in Utah. This appendix concludes with a presentation of the aircraft flight data and power and energy requirements synthesized and derived from the combination of all three industry segment forecasts (Section A.4 Combined Statewide Forecasts).

A.1 Flight School Forecast

Table 11. Airport location and code key

Airport Location	Airport Code	Airport Location	Airport Code
Parowan, UT	1L9	Pocatello, ID	PIH
Billings, MT	BIL	No Airport, UT	Park City*
Brigham City, UT	BMC	Phoenix, AZ	PHX
Bountiful (Skypark), UT	BTF	Price, UT	PUC
Cedar City, UT	CDC	Provo, UT	PVU
Moab, UT	CNY	Rock Springs, WY	RKS
Denver, CO	DEN	Rexburg, ID	RXE
Elko, NV	EKO	St. George, UT	SGU
ELY, NV	ELY	Salt Lake International, UT	SLC
Wendover, UT	ENV	Spanish Fork, UT	SPK
Heber City, UT	HCR	Twin Falls, ID	TWF
Idaho Falls, ID	IDA	No Existing Airport, UT	Thanksgiving Point*
Jackson, WY	JAC	No Existing Airport, UT	The Point*
Hailey, ID	KSUN	West Jordan (South Valley), UT	U42
Las Vegas, NV	KLAS	Vernal, UT	VEL
Logan, UT	LGU	Winnemucca, NV	WMC
Nephi, UT	NPH		

Table 12. Flight school electrification forecast

Flight School	Aircraft	Aircraft Battery Size (kWh)	Avg DoD Per Flight	Charge Energy (kWh)	Charge Rate (kW)	Avg. Flights / Day / Aircraft	Number of Electric Aircraft 2024	2025	2026	2027	2028	2029	2030	Airport	% Recharge @ Base Airport	Satellite Airports	% Recharge @ Satellite Airports
UVU	eDA40	78.4	80%	62.7	188.1	4	5	10	10	20	20	20	20	PVU	85%	Spanish Fork, Heber, Nephi, West Jordan (South Valley)	15%
USU	eDA40	78.4	80%	62.7	188.1	4	4	6	9	12	15	15	15	LGU	90%	Brigham City	10%
SUU Opt. 1	eDA40	78.4	80%	62.7	188.1	4	1	4	4	4	5	5	5	CDC	100%		0%
SUU Opt. 2	eDA40 2.0 or other	? (80+)	? (80%)	? (62.7)	? (188.1)	? (4)	? (1)	? (4)	? (4)	8	10	10	10	CDC	85%	Parawon	15%

A.2 Thin-Haul/Commercial Forecast

Table 13. Existing Alpine Aviation Routes in Utah (Dec. 2021-Feb. 2022)

Alpine Aviation Daily Routes							
Origin	Dest	nm	Flights/day	Origin	Dest	nm	Flights/day
SLC	IDA	164	1	SLC	PIH	128	1
IDA	SLC	164		PIH	SLC	128	
SLC	RXE	194	1	SLC	WMC	265	1
RXE	SLC	194		WMC	ELY	167	
SLC	CDC	192	1	ELY	SLC	160	
CDC	SGU	44		SLC	TWF	152	1
SGU	SLC	236		TWF	SUN	62	

Alpine Aviation Daily Routes							
Origin	**Dest**	**nm**	**Flights/day**	**Origin**	**Dest**	**nm**	**Flights/day**
KSLC	KSUN	193	1	SUN	TWF	62	
KSUN	SPIH	83		TWF	SLC	152	
PIH	SLC	130		SLC	EKO	174	1
SLC	VEL	116	1	EKO	SLC	174	
VEL	PUC	74		SLC	BIL	337	1
PUC	SLC	91		BIL	SLC	337	
SLC	RKS	141	1	SLC	JAC	178	2
RKS	SLC	141		JAC	SLC	178	

Table 14. Replacement of existing logistic and passenger routes with electric aircraft routes, addition of some new routes on the north/south and east/west axes based on similar existing routes and proposed electrification hubs

Route Type	Route Orientation	Origin	Destination Airport	Distance (nm)	UT Charge Location	Status	Aircraft Type	Aircraft Battery Size (kWH)	kWh/ nm	DoD per Flight	Recharge kWh	Fast Charge Required	Recharge KW	Flights per day 2024	2025	2026	2027	2028	2029	2030
Logistic Routes		SGU	CDC	44	CDC	Existing	Tecnam Pvolt All-Electric	220	1.81	36%	79.7	No	79.7	0	1	1	1	1	1	1
		CDC	SGU	44	SGU	Existing	Tecnam Pvolt All-Electric	220	1.81	36%	79.7	No	79.7	0	1	1	1	1	1	1
		SLC	SGU	192	SGU	Existing	KingAir 350 Hybrid	300	0.94	60%	180.0	No	180.0	0	0	0	0	2	2	2
		SGU	SLC	236	SLC	Existing	KingAir 350 Hybrid	300	0.94	74%	221.3	No	221.3	0	0	0	0	2	2	2
		VEL	PCU	74	PCU	Existing	Tecnam Pvolt All-Electric	220	1.81	61%	134.1	No	134.1	0	1	1	1	1	1	1
		PCU	VEL	74	VEL	Existing	Tecnam Pvolt All-Electric	220	1.81	61%	134.1	No	134.1	0	1	1	1	1	1	1
		SLC	VEL	116	VEL	Existing	KingAir 350 Hybrid	300	0.94	36%	108.8	No	108.8	0	0	0	0	2	2	2
		VEL	SLC	91	SLC	Existing	KingAir 350 Hybrid	300	0.94	28%	85.3	No	85.3	0	0	0	0	2	2	2

Route Type	Route Orientation	Origin	Destination Airport	Distance (nm)	UT Charge Location	Status	Aircraft Type	Aircraft Battery Size (kWH)	kWh/ nm	DoD per Flight	Recharge kWh	Fast Charge Required	Recharge KW	Flights per day 2024	2025	2026	2027	2028	2029	2030
		IDA	SLC	164	SLC	Existing	Cessna Caravan Hybrid Logistic	72	0.17	38%	27.5	No	27.5	0	0	1	1	1	1	1
		TWF	SLC	152	SLC	Existing	Cessna Caravan Hybrid Logistic	72	0.17	35%	25.5	No	25.5	0	0	1	1	1	1	1
		PIH	SLC	130	SLC	Existing	Cessna Caravan Hybrid Logistic	72	0.17	30%	21.8	No	21.8	0	0	1	1	1	1	1
		IDA	SLC	164	SLC	Existing	KingAir 350 Hybrid	300	0.94	51%	153.8	No	153.8	0	0	0	0	2	2	2
		TWF	SLC	152	SLC	Existing	KingAir 350 Hybrid	300	0.94	48%	142.5	No	142.5	0	0	0	0	2	2	2
		PIH	SLC	130	SLC	Existing	KingAir 350 Hybrid	300	0.94	41%	121.9	No	121.9	0	0	0	0	2	2	2
		ELY	SLC	160	SLC	Existing	KingAir 350 Hybrid	300	0.94	50%	150.0	No	150.0	0	0	0	0	2	2	2
Passenger Routes	East/West Routes (Vernal-based)	SLC	VEL	115	VEL	Existing	Cessna Caravan Hybrid Passenger	40	0.12	35%	13.9	YES	41.8	0	1	2	3	4	4	4
		VEL	SLC	115	SLC	Existing	Cessna Caravan Hybrid Passenger	40	0.12	35%	13.9	YES	41.8	0	1	2	3	4	4	4
		VEL	DEN	225	N/A	Existing	Cessna Caravan Hybrid Passenger	40	0.12	68%	27.3	YES	81.8	0	4	4	4	8	8	8
		DEN	VEL	225	VEL	Existing	Cessna Caravan Hybrid Passenger	40	0.12	68%	27.3	YES	81.8	0	4	4	4	8	8	8
	East/West Routes (Canyonlands-based)	SLC	CNY	159	CNY	Existing	Cessna Caravan Hybrid Passenger	40	0.12	48%	19.3	YES	57.8	0	4	4	4	8	8	8
		CNY	SLC	159	SLC	Existing	Cessna Caravan Hybrid Passenger	40	0.12	48%	19.3	YES	57.8	0	4	4	4	8	8	8
		CNY	DEN	246	DEN	Existing	Cessna Caravan Hybrid Passenger	40	0.12	75%	29.8	YES	89.5	0	4	4	4	8	8	8
		DEN	CNY	246	CNY	Existing	Cessna Caravan Hybrid Passenger	40	0.12	75%	29.8	YES	89.5	0	4	4	4	8	8	8
		PVU	CNY	127	CNY	New	Cessna Caravan Hybrid Passenger	40	0.12	38%	15.4	YES	46.2	0	0	0	1	1	2	2
		CNY	PVU	127	PVU	New	Cessna Caravan Hybrid Passenger	40	0.12	38%	15.4	YES	46.2	0	0	0	1	1	2	2
		OGD	CNY	179	CNY	New	Cessna Caravan Hybrid Passenger	40	0.12	54%	21.7	YES	65.1	0	0	0	0	1	1	1

Route Type	Route Orient-ation	Origin	Destin-ation Airport	Dist-ance (nm)	UT Charge Location	Status	Aircraft Type	Aircraft Battery Size (kWH)	kWh/ nm	DoD per Flight	Recharge kWh	Fast Charge Required	Recharge KW	Flights per day 2024	2025	2026	2027	2028	2029	2030
		CNY	OGD	179	OGD	New	Cessna Caravan Hybrid Passenger	40	0.12	54%	21.7	YES	65.1	0	0	0	0	1	1	1
		SGU	CNY	206	CNY	New	Cessna Caravan Hybrid Passenger	40	0.12	62%	25.0	YES	74.9	0	0	0	0	1	1	1
		CNY	SGU	206	SGU	New	Cessna Caravan Hybrid Passenger	40	0.12	62%	25.0	YES	74.9	0	0	0	0	1	1	1
		LGU	CNY	206	CNY	New	Cessna Caravan Hybrid Passenger	40	0.12	62%	25.0	YES	74.9	0	0	0	0	0	1	1
		CNY	LGU	206	LGU	New	Cessna Caravan Hybrid Passenger	40	0.12	62%	25.0	YES	74.9	0	0	0	0	0	1	1
	North/South Routes (Logan-based)	LGU	SLC	60	SLC	New	Tecnam Pvolt All-Electric	220	1.81	49%	108.7	YES	326.1	0	1	2	3	4	4	4
		SLC	LGU	60	LGU	New	Tecnam Pvolt All-Electric	220	1.81	49%	108.7	YES	326.1	0	1	2	3	4	4	4
		LGU	BTF	55	BTF	New	Tecnam Pvolt All-Electric	220	1.81	45%	99.6	YES	298.9	0	0	0	1	1	2	2
		BTF	LGU	55	LGU	New	Tecnam Pvolt All-Electric	220	1.81	45%	99.6	YES	298.9	0	0	0	1	1	2	2
		LGU	U42	71	U42	New	Tecnam Pvolt All-Electric	220	1.81	58%	128.6	YES	385.9	0	0	0	1	1	2	2
		U42	LGU	71	LGU	New	Tecnam Pvolt All-Electric	220	1.81	58%	128.6	YES	385.9	0	0	0	1	1	2	2
		LGU	PVU	94	PVU	New	Cessna Caravan Hybrid Passenger	40	0.12	28%	11.4	YES	34.2	0	0	1	2	2	3	3
		PVU	LGU	94	LGU	New	Cessna Caravan Hybrid Passenger	40	0.12	28%	11.4	YES	34.2	0	0	1	2	2	3	3
		LGU	CDC	252	CDC	New	Cessna Caravan Hybrid Passenger	40	0.12	76%	30.5	YES	91.6	0	0	0	0	1	1	1
		CDC	LGU	252	LGU	New	Cessna Caravan Hybrid Passenger	40	0.12	76%	30.5	YES	91.6	0	0	0	0	1	1	1
		LGU	SGU	295	SGU	New	Cessna Caravan Hybrid Passenger	40	0.12	89%	35.8	YES	107.3	0	0	1	1	1	2	2
		SGU	LGU	295	LGU	New	Cessna Caravan Hybrid Passenger	40	0.12	89%	35.8	YES	107.3	0	0	1	1	1	2	2

Route Type	Route Orient-ation	Origin	Destin-ation Airport	Dist-ance (nm)	UT Charge Location	Status	Aircraft Type	Aircraft Battery Size (kWH)	kWh/ nm	DoD per Flight	Recharge kWh	Fast Charge Required	Recharge KW	Flights per day 2024	2025	2026	2027	2028	2029	2030
	North/South Routes (St. George/Cedar City-based)	SLC	SGU	236	SGU	Existing	Cessna Caravan Hybrid Passenger	40	0.12	72%	28.6	YES	85.8	0	4	4	4	8	8	8
		SGU	SLC	236	SLC	Existing	Cessna Caravan Hybrid Passenger	40	0.12	72%	28.6	YES	85.8	0	4	4	4	8	8	8
		SLC	CDC	192	CDC	Existing	Cessna Caravan Hybrid Passenger	40	0.12	58%	23.3	YES	69.8	0	4	4	4	8	8	8
		CDC	SLC	192	SLC	Existing	Cessna Caravan Hybrid Passenger	40	0.12	58%	23.3	YES	69.8	0	4	4	4	8	8	8
		CDC	KLAS	139	N/A	Existing	Cessna Caravan Hybrid Passenger	40	0.12	42%	16.8	YES	50.5	0	1	2	2	3	3	4
		KLAS	CDC	139	CDC	Existing	Cessna Caravan Hybrid Passenger	40	0.12	42%	16.8	YES	50.5	0	1	2	2	3	3	4
		SGU	KLAS	98	N/A	Existing	Cessna Caravan Hybrid Passenger	40	0.12	30%	11.9	YES	35.6	0	1	2	2	3	3	4
		KLAS	SGU	98	SGU	Existing	Cessna Caravan Hybrid Passenger	40	0.12	30%	11.9	YES	35.6	0	1	2	2	3	3	4
		SLC	ENV	94	ENV	Existing	Cessna Caravan Hybrid Passenger	40	0.12	28%	11.4	YES	34.2	0	1	1	1	2	2	2
		ENV	SLC	94	SLC	Existing	Cessna Caravan Hybrid Passenger	40	0.12	28%	11.4	YES	34.2	0	1	1	1	2	2	2
		SGU	PVU	208	PVU	Existing	Cessna Caravan Hybrid Passenger	40	0.12	63%	25.2	YES	75.6	0	0	1	1	2	2	2
		PVU	SGU	208	SGU	Existing	Cessna Caravan Hybrid Passenger	40	0.12	63%	25.2	YES	75.6	0	0	1	1	2	2	2
		SGU	PHX	228	N/A	Existing	Cessna Caravan Hybrid Passenger	40	0.12	69%	27.6	YES	82.9	0	3	3	4	4	4	4
		PHX	SGU	228	SGU	Existing	Cessna Caravan Hybrid Passenger	40	0.12	69%	27.6	YES	82.9	0	3	3	4	4	4	4

A.3 AAM Forecast

Table 15. AAM electrification forecast

						Number of Daily Flights											Energy Consumption by All Daily Flights						
Provider	Hub	Origin	Destination	Charging Destination	Nautical Miles (nm)	2024	2025	2026	2027	2028	2029	2030	E for Lift/ Land (kWh)	kWh/ nm Cruise	kWh/ flight	kW	kWh 2024	kWh 2025	kWh 2026	kWh 2027	kWh 2028	kWh 2029	kWh 2030
OGD-SLC Shuttle Service	OGD	OGD	Layton/South HAFB*	OGD	10.0	0	0	0	2	2	4	4	25	1	35.0	105.0	0.0	0.0	0.0	70.0	70.0	140.0	140.0
		OGD	SLC	SLC	24.7	0	0	0	4	8	12	12	25	1	49.7	149.0	0.0	0.0	0.0	198.6	397.2	595.8	595.8
		SLC	OGD	OGD	24.7	0	0	0	4	8	12	12	25	1	49.7	149.0	0.0	0.0	0.0	198.6	397.2	595.8	595.8
SLC General Service	SLC/ U42	SLC	Layton/South HAFB* to OGD	OGD	25.4	0	0	0	2	4	8	8	25	1	50.4	151.1	0.0	0.0	0.0	100.8	201.5	403.0	403.0
		OGD	Layton/South HAFB* to SLC	SLC	25.4	0	0	0	2	4	8	8	25	1	50.4	151.1	0.0	0.0	0.0	100.8	201.5	403.0	403.0
		SLC	City Creek* to U of U*	SLC	13.4	0	0	4	6	12	16	18	25	1	38.4	115.2	0.0	0.0	153.6	230.4	460.8	614.4	691.2
		SLC	U42	SLC	18.7	0	0	0	2	4	8	10	25	1	43.7	131.2	0.0	0.0	0.0	87.5	174.9	349.8	437.3
		U42	SLC	U42	18.7	0	0	0	2	4	8	10	25	1	43.7	131.2	0.0	0.0	0.0	87.5	174.9	349.8	437.3
		SLC	Park City*	Park City*	24.7	0	0	2	4	8	12	14	25	1	49.7	149.0	0.0	0.0	99.3	198.6	397.3	595.9	695.2
		Park City*	SLC	SLC	20.4	0	0	2	4	8	12	14	25	1	45.4	136.3	0.0	0.0	90.8	181.7	363.4	545.0	635.9
		SLC	The Point*	The Point*	15.6	0	0	2	4	8	12	14	25	1	40.6	121.7	0.0	0.0	81.2	162.3	324.6	487.0	568.1
		The Point*	SLC	SLC	15.6	0	0	2	4	8	12	14	25	1	40.6	121.7	0.0	0.0	81.2	162.3	324.6	487.0	568.1
		SLC	Thanksgiving Point*	Thanksgiving Point*	23.1	0	0	0	2	4	8	10	25	1	48.1	144.4	0.0	0.0	0.0	96.3	192.5	385.0	481.3
		Thanks-giving Point*	SLC	SLC	23.1	0	0	0	2	4	8	10	25	1	48.1	144.4	0.0	0.0	0.0	96.3	192.5	385.0	481.3
		U42	City Creek* to U of U*	U42	22.3	0	0	0	2	4	8	10	25	1	47.3	141.9	0.0	0.0	0.0	94.6	189.2	378.3	472.9
		U42	The Point* to Thanksgiving Point*	U42	12.4	0	0	0	4	6	8	10	25	1	37.4	112.3	0.0	0.0	0.0	149.7	224.6	299.4	374.3
		U42	PVU	PVU	27.0	0	0	0	2	4	6	8	25	1	52.0	156.1	0.0	0.0	0.0	104.0	208.1	312.1	416.2

						Number of Daily Flights											Energy Consumption by All Daily Flights						
Provider	Hub	Origin	Destination	Charging Destin-ation	Nautical Miles (nm)	2024	2025	2026	2027	2028	2029	2030	E for Lift/ Land (kWh)	kWh/ nm Cruise	kWh/ flight	kW	kWh 2024	kWh 2025	kWh 2026	kWh 2027	kWh 2028	kWh 2029	kWh 2030
		PVU	U42	U42	27.0	0	0	0	2	4	6	8	25	1	52.0	156.1	0.0	0.0	0.0	104.0	208.1	312.1	416.2
		PVU	Thanksgiving Point* to The Point*	The Point*	20.2	0	0	0	2	4	4	6	25	1	45.2	135.6	0.0	0.0	0.0	90.4	180.8	180.8	271.2
		The Point*	Thanksgiving Point* to PVU	PVU	20.2	0	0	0	2	4	4	6	25	1	45.2	135.6	0.0	0.0	0.0	90.4	180.8	180.8	271.2
		PVU	Provo City Center* to BYU*	PVU	7.6	0	0	0	0	2	2	4	25	1	32.6	97.9	0.0	0.0	0.0	0.0	65.3	65.3	130.6
Point of the Mtn. Business Center Service	SLC/ U42	SLC	City Creek* to The Point*	The Point*	19.0	0	0	0	8	8	12	18	25	1	44.0	132.0	0.0	0.0	0.0	351.9	351.9	527.9	791.8
		The Point*	City Creek* to SLC	SLC	19.0	0	0	0	8	8	12	18	25	1	44.0	132.0	0.0	0.0	0.0	351.9	351.9	527.9	791.8
		The Point*	Park City*	Park City*	19.0	0	0	0	6	6	8	12	25	1	44.0	132.0	0.0	0.0	0.0	263.9	263.9	351.9	527.9
		Park City*	The Point*	The Point*	19.0	0	0	0	6	6	8	12	25	1	44.0	132.0	0.0	0.0	0.0	263.9	263.9	351.9	527.9
		The Point*	Thanksgiving Point* to Provo City Center* to PVU	PVU	20.2	0	0	0	8	8	12	16	25	1	45.2	135.6	0.0	0.0	0.0	361.6	361.6	542.4	723.2
		PVU	Provo City Center* to Thanksgiving Point* to The Point*	The Point*	20.2	0	0	0	8	8	12	16	25	1	45.2	135.6	0.0	0.0	0.0	361.6	361.6	542.4	723.2
Ski Industry Service	N/A	OGD	Snowbasin* to Nordic Valley* to Powder Mountain* to OGD	OGD	34.1	0	0	0	0	2	2	4	25	1	59.1	177.4	0.0	0.0	0.0	0.0	118.2	118.2	236.5

					Number of Daily Flights												Energy Consumption by All Daily Flights						
Provider	Hub	Origin	Destination	Charging Destination	Nautical Miles (nm)	2024	2025	2026	2027	2028	2029	2030	E for Lift/ Land (kWh)	kWh/ nm Cruise	kWh/ flight	kW	kWh 2024	kWh 2025	kWh 2026	kWh 2027	kWh 2028	kWh 2029	kWh 2030
		SLC	Snowbird/Alta Park and Ride* to Solitude/Brighton Park and Ride* to SLC	SLC	32.2	0	0	2	2	6	8	10	25	1	57.2	171.5	0.0	0.0	114.3	114.3	343.0	457.4	571.7
		SLC	Park City*	Park City*	24.7	0	0	2	2	6	8	10	25	1	49.7	149.0	0.0	0.0	99.3	99.3	298.0	397.3	496.6
		Park City*	SLC	SLC	24.7	0	0	2	2	6	8	10	25	1	49.7	149.0	0.0	0.0	99.3	99.3	298.0	397.3	496.6

A.4 Combined Statewide Forecasts

Table 16. Combined statewide aviation electrification forecast for flight school, thin haul/commercial, and AAM industry segments

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
SGU	CDC	44	CDC	TH/C Logistic	Tecnam Pvolt All-Electric	220		1.81	36%	79.7	NO	79.7	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1
CDC	SGU	44	SGU	TH/C Logistic	Tecnam Pvolt All-Electric	220		1.81	36%	79.7	NO	79.7	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1
SLC	SGU	192	SGU	TH/C Logistic	KingAir 350 Hybrid	300		0.94	60%	180.0	NO	180.0	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2
SGU	SLC	236	SLC	TH/C Logistic	KingAir 350 Hybrid	300		0.94	74%	221.3	NO	221.3	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
VEL	PUC	74	PUC	TH/C Logistic	Tecnam Pvolt All-Electric	220		1.81	61%	134.1	NO	134.1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1
PUC	VEL	74	VEL	TH/C Logistic	Tecnam Pvolt All-Electric	220		1.81	61%	134.1	NO	134.1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1
SLC	VEL	116	VEL	TH/C Logistic	KingAir 350 Hybrid	300		0.94	36%	108.8	NO	108.8	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2
VEL	SLC	91	SLC	TH/C Logistic	KingAir 350 Hybrid	300		0.94	28%	85.3	NO	85.3	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2
IDA	SLC	164	SLC	TH/C Logistic	Cessna Caravan Hybrid Logistic	72		0.17	38%	27.5	NO	27.5	1	0	0	1	1	1	1	1	0	0	1	1	1	1	1
TWF	SLC	152	SLC	TH/C Logistic	Cessna Caravan Hybrid Logistic	72		0.17	35%	25.5	NO	25.5	1	0	0	1	1	1	1	1	0	0	1	1	1	1	1
PIH	SLC	130	SLC	TH/C Logistic	Cessna Caravan Hybrid Logistic	72		0.17	30%	21.8	NO	21.8	1	0	0	1	1	1	1	1	0	0	1	1	1	1	1
IDA	SLC	164	SLC	TH/C Logistic	KingAir 350 Hybrid	300		0.94	51%	153.8	NO	153.8	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2
TWF	SLC	152	SLC	TH/C Logistic	KingAir 350 Hybrid	300		0.94	48%	142.5	NO	142.5	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2
PIH	SLC	130	SLC	TH/C Logistic	KingAir 350 Hybrid	300		0.94	41%	121.9	NO	121.9	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2
ELY	SLC	160	SLC	TH/C Logistic	KingAir 350 Hybrid	300		0.94	50%	150.0	NO	150.0	1	0	0	0	0	2	2	2	0	0	0	0	2	2	2
SLC	VEL	115	VEL	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	35%	13.9	YES	41.8	3	0	1	2	3	4	4	4	0	1	1	1	1	1	1

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
VEL	SLC	115	SLC	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	35%	13.9	YES	41.8	3	0	1	2	3	4	4	4	0	1	1	1	1	1	1
VEL	DEN	225	DEN	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	68%	27.3	YES	81.8	3	0	4	4	4	8	8	8	0	1	1	1	2	2	2
DEN	VEL	225	VEL	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	68%	27.3	YES	81.8	3	0	4	4	4	8	8	8	0	1	1	1	2	2	2
LGU	SLC	60	SLC	TH/C Passenger	Tecnam Pvolt All-Electric	220		1.81	49%	108.7	YES	326.1	3	0	1	2	3	4	4	4	0	1	1	1	1	1	1
SLC	LGU	60	LGU	TH/C Passenger	Tecnam Pvolt All-Electric	220		1.81	49%	108.7	YES	326.1	3	0	1	2	3	4	4	4	0	1	1	1	1	1	1
LGU	BTF	55	BTF	TH/C Passenger	Tecnam Pvolt All-Electric	220		1.81	45%	99.6	YES	298.9	3	0	0	0	1	1	2	2	0	0	0	1	1	1	1
BTF	LGU	55	LGU	TH/C Passenger	Tecnam Pvolt All-Electric	220		1.81	45%	99.6	YES	298.9	3	0	0	0	1	1	2	2	0	0	0	1	1	1	1
LGU	U42	71	U42	TH/C Passenger	Tecnam Pvolt All-Electric	220		1.81	58%	128.6	YES	385.9	3	0	0	0	1	1	2	2	0	0	0	1	1	1	1
U42	LGU	71	LGU	TH/C Passenger	Tecnam Pvolt All-Electric	220		1.81	58%	128.6	YES	385.9	3	0	0	0	1	1	2	2	0	0	0	1	1	1	1
LGU	PVU	94	PVU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	28%	11.4	YES	34.2	3	0	0	1	2	2	3	3	0	0	1	1	1	1	1
PVU	LGU	94	LGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	28%	11.4	YES	34.2	3	0	0	1	2	2	3	3	0	0	1	1	1	1	1
LGU	CDC	252	CDC	TH/C Passenger	Cessna Caravan	40		0.12	76%	30.5	YES	91.6	3	0	0	0	0	1	1	1	0	0	0	0	1	1	1

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
					Hybrid Passenger																						
CDC	LGU	252	LGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	76%	30.5	YES	91.6	3	0	0	0	0	1	1	1	0	0	0	0	1	1	1
LGU	SGU	295	SGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	89%	35.8	YES	107.3	3	0	0	1	1	1	2	2	0	0	1	1	1	1	1
SGU	LGU	295	LGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	89%	35.8	YES	107.3	3	0	0	1	1	1	2	2	0	0	1	1	1	1	1
SLC	CNY	159	CNY	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	48%	19.3	YES	57.8	3	0	4	4	4	8	8	8	0	1	1	1	2	2	2
CNY	SLC	159	SLC	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	48%	19.3	YES	57.8	3	0	4	4	4	8	8	8	0	1	1	1	2	2	2
CNY	DEN	246	DEN	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	75%	29.8	YES	89.5	3	0	4	4	4	8	8	8	0	1	1	1	2	2	2
DEN	CNY	246	CNY	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	75%	29.8	YES	89.5	3	0	4	4	4	8	8	8	0	1	1	1	2	2	2
PVU	CNY	127	CNY	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	38%	15.4	YES	46.2	3	0	0	0	1	1	2	2	0	0	0	1	1	1	1
CNY	PVU	127	PVU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	38%	15.4	YES	46.2	3	0	0	0	1	1	2	2	0	0	0	1	1	1	1
OGD	CNY	179	CNY	TH/C Passenger	Cessna Caravan	40		0.12	54%	21.7	YES	65.1	3	0	0	0	0	1	1	1	0	0	0	0	1	1	1

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
					Hybrid Passenger																						
CNY	OGD	179	OGD	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	54%	21.7	YES	65.1	3	0	0	0	0	1	1	1	0	0	0	0	1	1	1
SGU	CNY	206	CNY	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	62%	25.0	YES	74.9	3	0	0	0	0	1	1	1	0	0	0	0	1	1	1
CNY	SGU	206	SGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	62%	25.0	YES	74.9	3	0	0	0	0	1	1	1	0	0	0	0	1	1	1
LGU	CNY	206	CNY	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	62%	25.0	YES	74.9	3	0	0	0	0	0	1	1	0	0	0	0	0	1	1
CNY	LGU	206	LGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	62%	25.0	YES	74.9	3	0	0	0	0	0	1	1	0	0	0	0	0	1	1
SLC	SGU	236	SGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	72%	28.6	YES	85.8	3	0	4	4	4	8	8	8	0	1	1	1	1	1	1
SGU	SLC	236	SLC	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	72%	28.6	YES	85.8	3	0	4	4	4	8	8	8	0	1	1	1	1	1	1
SLC	CDC	192	CDC	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	58%	23.3	YES	69.8	3	0	4	4	4	8	8	8	0	1	1	1	1	1	1
CDC	SLC	192	SLC	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	58%	23.3	YES	69.8	3	0	4	4	4	8	8	8	0	1	1	1	1	1	1
CDC	KLAS~	139	KLAS	TH/C Passenger	Cessna Caravan	40		0.12	42%	16.8	YES	50.5	3	0	1	2	2	3	3	4	0	1	1	1	1	1	1

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
					Hybrid Passenger																						
KLAS	CDC	139	CDC	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	42%	16.8	YES	50.5	3	0	1	2	2	3	3	4	0	1	1	1	1	1	1
SGU	KLAS~	98	KLAS	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	30%	11.9	YES	35.6	3	0	1	2	2	3	3	4	0	1	1	1	1	1	1
KLAS	SGU	98	SGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	30%	11.9	YES	35.6	3	0	1	2	2	3	3	4	0	1	1	1	1	1	1
ENV	SLC	94	SLC	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	28%	11.4	YES	34.2	3	0	1	2	3	4	4	4	0	1	1	1	1	1	1
SLC	ENV	94	ENV	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	28%	11.4	YES	34.2	3	0	1	2	3	4	4	4	0	1	1	1	1	1	1
SGU	PVU	208	PVU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	63%	25.2	YES	75.6	3	0	0	1	1	2	2	2	0	0	1	1	1	1	1
PVU	SGU	208	SGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	63%	25.2	YES	75.6	3	0	0	1	1	2	2	2	0	0	1	1	1	1	1
SGU	PHX	228	PHX	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	69%	27.6	YES	82.9	3	0	3	3	4	4	4	4	0	1	1	1	2	2	2
PHX	SGU	228	SGU	TH/C Passenger	Cessna Caravan Hybrid Passenger	40		0.12	69%	27.6	YES	82.9	3	0	3	3	4	4	4	4	0	1	1	1	2	2	2
PVU	*A	*A	PVU	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	17	34	34	68	68	68	68	5	10	10	20	20	20	20

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
U42	*A	*A	U42	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	1	1	1	3	3	3	3	2	4	4	6	6	7	7
HCR	*A	*A	HCR	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	1	1	1	3	3	3	3	2	4	4	6	6	7	7
NPH	*A	*A	NPH	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	1	1	1	3	3	3	3	2	4	4	6	6	7	7
SPK	*A	*A	SPK	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	1	1	1	3	3	3	3	2	4	4	6	6	7	7
LGU	*A	*A	LGU	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	14	22	32	43	54	54	54	4	6	9	12	15	15	15
BMC	*A	*A	BMC	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	1	2	3	4	5	5	5	1	2	3	4	5	5	6
CDC	*A	*A	CDC	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	4	16	16	16	20	20	20	1	4	4	4	5	5	5
1L9	*A	*A	1L9	Flight School	eDA40	78.37		*A	80%	62.7	YES	188.1	3	1	2	2	2	3	3	3	1	2	2	2	2	2	2
OGD	Layton/South HAFB*	10.0	OGD	AAM	*B	*B	25	1.00	*B	35.0	YES	105.0	3	0	0	0	2	2	4	4	0	0	0	1	1	1	1
OGD	SLC	24.7	SLC	AAM	*B	*B	25	1.00	*B	49.7	YES	149.0	3	0	0	0	4	8	12	12	0	0	0	1	2	3	3
SLC	OGD	24.7	OGD	AAM	*B	*B	25	1.00	*B	49.7	YES	149.0	3	0	0	0	4	8	12	12	0	0	0	1	2	3	3
SLC	Layton/South HAFB* to OGD	25.4	OGD	AAM	*B	*B	25	1.00	*B	50.4	YES	151.1	3	0	0	0	2	4	8	8	0	0	0	1	1	2	2
OGD	Layton/South HAFB* to SLC	25.4	SLC	AAM	*B	*B	25	1.00	*B	50.4	YES	151.1	3	0	0	0	2	4	8	8	0	0	0	1	1	2	2
SLC	City Creek* to U of U*	13.4	SLC	AAM	*B	*B	25	1.00	*B	38.4	YES	115.2	3	0	0	4	6	12	16	18	0	0	1	2	3	4	4
U42	SLC	18.7	SLC	AAM	*B	*B	25	1.00	*B	43.7	YES	131.2	3	0	0	0	2	4	8	10	0	0	0	1	1	2	3
SLC	U42	18.7	U42	AAM	*B	*B	25	1.00	*B	43.7	YES	131.2	3	0	0	0	2	4	8	10	0	0	0	1	1	2	3
SLC	Park City*	24.7	Park City*	AAM	*B	*B	25	1.00	*B	49.7	YES	149.0	3	0	0	2	4	8	12	14	0	0	1	1	2	3	4
Park City*	SLC	20.4	SLC	AAM	*B	*B	25	1.00	*B	45.4	YES	136.3	3	0	0	2	4	8	12	14	0	0	1	1	2	3	4

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
SLC	The Point*	15.6	The Point*	AAM	*B	*B	25	1.00	*B	40.6	YES	121.7	3	0	0	2	4	8	12	14	0	0	1	1	2	3	4
The Point*	SLC	15.6	SLC	AAM	*B	*B	25	1.00	*B	40.6	YES	121.7	3	0	0	2	4	8	12	14	0	0	1	1	2	3	4
SLC	Thanksgiving Point*	23.1	Thanksgiving Point*	AAM	*B	*B	25	1.00	*B	48.1	YES	144.4	3	0	0	0	2	4	8	10	0	0	0	1	1	2	2
Thanksgiving Point*	SLC	23.1	SLC	AAM	*B	*B	25	1.00	*B	48.1	YES	144.4	3	0	0	0	2	4	8	10	0	0	0	1	1	2	2
U42	City Creek* to U of U*	22.3	U42	AAM	*B	*B	25	1.00	*B	47.3	YES	141.9	3	0	0	0	2	4	8	10	0	0	0	1	1	2	2
U42	The Point* to Thanksgiving Point*	12.4	U42	AAM	*B	*B	25	1.00	*B	37.4	YES	112.3	3	0	0	0	4	6	8	10	0	0	0	1	1	2	2
U42	PVU	27.0	PVU	AAM	*B	*B	25	1.00	*B	52.0	YES	156.1	3	0	0	0	2	4	6	8	0	0	0	1	1	2	2
PVU	U42	27.0	U42	AAM	*B	*B	25	1.00	*B	52.0	YES	156.1	3	0	0	0	2	4	6	8	0	0	0	1	1	2	2
PVU	Thanksgiving Point* to The Point*	20.2	The Point*	AAM	*B	*B	25	1.00	*B	45.2	YES	135.6	3	0	0	0	2	4	4	6	0	0	0	1	1	1	2
The Point*	Thanksgiving Point* to PVU	20.2	PVU	AAM	*B	*B	25	1.00	*B	45.2	YES	135.6	3	0	0	0	2	4	4	6	0	0	0	1	1	1	2
PVU	Provo City Center* to BYU*	7.6	PVU	AAM	*B	*B	25	1.00	*B	32.6	YES	97.9	3	0	0	0	0	2	2	4	0	0	0	0	1	1	1
SLC	City Creek* to The Point*	19.0	The Point*	AAM	*B	*B	25	1.00	*B	44.0	YES	132.0	3	0	0	0	8	8	12	18	0	0	0	2	2	3	4
The Point*	City Creek* to SLC	19.0	SLC	AAM	*B	*B	25	1.00	*B	44.0	YES	132.0	3	0	0	0	8	8	12	18	0	0	0	2	2	3	4
The Point*	Park City*	19.0	Park City*	AAM	*B	*B	25	1.00	*B	44.0	YES	132.0	3	0	0	0	6	6	8	12	0	0	0	1	1	2	3
Park City*	The Point*	19.0	The Point*	AAM	*B	*B	25	1.00	*B	44.0	YES	132.0	3	0	0	0	6	6	8	12	0	0	0	1	1	2	3

Origin/ Charge Location	Destination	Distance (nm)	Airport	Type	Possible Aircraft	Battery Size (kWh)	kWh/ takeoff and land (EVTOL)	kWh/ nm	DoD	Recharge Required (kWh)	Fast Charge	Recharge Rate (kW)	C Rate	Daily Flights 2024	Daily Flights 2025	Daily Flights 2026	Daily Flights 2027	Daily Flights 2028	Daily Flights 2029	Daily Flights 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030
The Point*	Thanksgiving Point* to Provo City Center* to PVU	20.2	PVU	AAM	*B	*B	25	1.00	*B	45.2	YES	135.6	3	0	0	0	8	8	12	16	0	0	0	2	2	3	4
PVU	Provo City Center* to Thanksgiving Point* to The Point*	20.2	The Point*	AAM	*B	*B	25	1.00	*B	45.2	YES	135.6	3	0	0	0	8	8	12	16	0	0	0	2	2	3	4
OGD	Snowbasin* to Nordic Valley* to Powder Mountain* to OGD	34.1	OGD	AAM	*B	*B	25	1.00	*B	59.1	YES	177.4	3	0	0	0	0	2	2	4	0	0	0	0	1	1	1
SLC	Snowbird/ Alta Park and Ride* to Solitude/ Brighton Park and Ride* to SLC	32.2	SLC	AAM	*B	*B	25	1.00	*B	57.2	YES	171.5	3	0	0	2	2	6	8	10	0	0	1	1	1	2	2
SLC	Park City*	24.7	Park City*	AAM	*B	*B	25	1.00	*B	49.7	YES	149.0	3	0	0	2	2	6	8	10	0	0	1	1	1	2	2
Park City*	SLC	24.7	SLC	AAM	*B	*B	25	1.00	*B	49.7	YES	149.0	3	0	0	2	2	6	8	10	0	0	1	1	1	2	2

* Electric aircraft hubs that are not located at existing airports

*A Flight school operational profiles are somewhat chaotic in nature, so instead of a certain destination, travel distance, or energy consumption per distance travelled, it is assumed that flight school aircraft use 80% of their available energy every flight.

*B The aircraft operated in AAM capacities are outlined in Section 2.4. The battery size and depth of discharge, as they are not fully defined by the aircraft developers, are substituted by a general energy consumption rate per nautical mile travelled.

Table 17. Combined statewide aviation electrification forecast energy/power requirements for flight school, thin haul/commercial, and AAM industry segments

Origin/ Charge Loc	Destination	Daily kWh 2024	Daily kWh 2025	Daily kWh 2026	Daily kWh 2027	Daily kWh 2028	Daily kWh 2029	Daily kWh 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030	Total Simultaneous Power (kW) 2024 WORST CASE	Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#plans/2)
SGU	CDC	0	79.7	79.7	79.7	79.7	79.7	79.7	0	1	1	1	1	1	1	0	79.7	79.7	79.7	79.7	79.7	79.7	0	79.7	79.7	79.7	79.7	79.7
CDC	SGU	0	79.7	79.7	79.7	79.7	79.7	79.7	0	1	1	1	1	1	1	0	79.7	79.7	79.7	79.7	79.7	79.7	0	79.7	79.7	79.7	79.7	79.7
SLC	SGU	0	0.0	0.0	0.0	360.0	360.0	360.0	0	0	0	0	2	2	2	0	0.0	0.0	0.0	360.0	360.0	360.0	0	0.0	0.0	0.0	180.0	180.0
SGU	SLC	0	0.0	0.0	0.0	442.5	442.5	442.5	0	0	0	0	2	2	2	0	0.0	0.0	0.0	442.5	442.5	442.5	0	0.0	0.0	0.0	221.3	221.3
VEL	PUC	0	134.1	134.1	134.1	134.1	134.1	134.1	0	1	1	1	1	1	1	0	134.1	134.1	134.1	134.1	134.1	134.1	0	134.1	134.1	134.1	134.1	134.1
PUC	VEL	0	134.1	134.1	134.1	134.1	134.1	134.1	0	1	1	1	1	1	1	0	134.1	134.1	134.1	134.1	134.1	134.1	0	134.1	134.1	134.1	134.1	134.1
SLC	VEL	0	0.0	0.0	0.0	217.5	217.5	217.5	0	0	0	0	2	2	2	0	0.0	0.0	0.0	217.5	217.5	217.5	0	0.0	0.0	0.0	108.8	108.8
VEL	SLC	0	0.0	0.0	0.0	170.6	170.6	170.6	0	0	0	0	2	2	2	0	0.0	0.0	0.0	170.6	170.6	170.6	0	0.0	0.0	0.0	85.3	85.3
IDA	SLC	0	0.0	27.5	27.5	27.5	27.5	27.5	0	0	1	1	1	1	1	0	0.0	27.5	27.5	27.5	27.5	27.5	0	0.0	27.5	27.5	27.5	27.5
TWF	SLC	0	0.0	25.5	25.5	25.5	25.5	25.5	0	0	1	1	1	1	1	0	0.0	25.5	25.5	25.5	25.5	25.5	0	0.0	25.5	25.5	25.5	25.5
PIH	SLC	0	0.0	21.8	21.8	21.8	21.8	21.8	0	0	1	1	1	1	1	0	0.0	21.8	21.8	21.8	21.8	21.8	0	0.0	21.8	21.8	21.8	21.8
IDA	SLC	0	0.0	0.0	0.0	307.5	307.5	307.5	0	0	0	0	2	2	2	0	0.0	0.0	0.0	307.5	307.5	307.5	0	0.0	0.0	0.0	153.8	153.8
TWF	SLC	0	0.0	0.0	0.0	285.0	285.0	285.0	0	0	0	0	2	2	2	0	0.0	0.0	0.0	285.0	285.0	285.0	0	0.0	0.0	0.0	142.5	142.5
PIH	SLC	0	0.0	0.0	0.0	243.8	243.8	243.8	0	0	0	0	2	2	2	0	0.0	0.0	0.0	243.8	243.8	243.8	0	0.0	0.0	0.0	121.9	121.9
ELY	SLC	0	0.0	0.0	0.0	300.0	300.0	300.0	0	0	0	0	2	2	2	0	0.0	0.0	0.0	300.0	300.0	300.0	0	0.0	0.0	0.0	150.0	150.0
SLC	VEL	0	13.9	27.9	41.8	55.8	55.8	55.8	0	1	1	1	1	1	1	0	41.8	41.8	41.8	41.8	41.8	41.8	0	41.8	41.8	41.8	41.8	41.8
VEL	SLC	0	13.9	27.9	41.8	55.8	55.8	55.8	0	1	1	1	1	1	1	0	41.8	41.8	41.8	41.8	41.8	41.8	0	41.8	41.8	41.8	41.8	41.8

Origin/ Charge Loc	Destination	Daily kWh 2024	Daily kWh 2025	Daily kWh 2026	Daily kWh 2027	Daily kWh 2028	Daily kWh 2029	Daily kWh 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030	Total Simultaneous Power (kW) 2024 WORST CASE	Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#plans/2)
VEL	DEN	0	109.1	109.1	109.1	218.2	218.2	218.2	0	1	1	1	2	2	2	0	81.8	81.8	81.8	163.6	163.6	163.6	0	81.8	81.8	81.8	81.8	81.8
DEN	VEL	0	109.1	109.1	109.1	218.2	218.2	218.2	0	1	1	1	2	2	2	0	81.8	81.8	81.8	163.6	163.6	163.6	0	81.8	81.8	81.8	81.8	81.8
LGU	SLC	0	108.7	217.4	326.1	434.8	434.8	434.8	0	1	1	1	1	1	1	0	326.1	326.1	326.1	326.1	326.1	326.1	0	326.1	326.1	326.1	326.1	326.1
SLC	LGU	0	108.7	217.4	326.1	434.8	434.8	434.8	0	1	1	1	1	1	1	0	326.1	326.1	326.1	326.1	326.1	326.1	0	326.1	326.1	326.1	326.1	326.1
LGU	BTF	0	0.0	0.0	99.6	99.6	199.3	199.3	0	0	0	1	1	1	1	0	0.0	0.0	298.9	298.9	298.9	298.9	0	0.0	0.0	298.9	298.9	298.9
BTF	LGU	0	0.0	0.0	99.6	99.6	199.3	199.3	0	0	0	1	1	1	1	0	0.0	0.0	298.9	298.9	298.9	298.9	0	0.0	0.0	298.9	298.9	298.9
LGU	U42	0	0.0	0.0	128.6	128.6	257.3	257.3	0	0	0	1	1	1	1	0	0.0	0.0	385.9	385.9	385.9	385.9	0	0.0	0.0	385.9	385.9	385.9
U42	LGU	0	0.0	0.0	128.6	128.6	257.3	257.3	0	0	0	1	1	1	1	0	0.0	0.0	385.9	385.9	385.9	385.9	0	0.0	0.0	385.9	385.9	385.9
LGU	PVU	0	0.0	11.4	22.8	22.8	34.2	34.2	0	0	1	1	1	1	1	0	0.0	34.2	34.2	34.2	34.2	34.2	0	0.0	34.2	34.2	34.2	34.2
PVU	LGU	0	0.0	11.4	22.8	22.8	34.2	34.2	0	0	1	1	1	1	1	0	0.0	34.2	34.2	34.2	34.2	34.2	0	0.0	34.2	34.2	34.2	34.2
LGU	CDC	0	0.0	0.0	0.0	30.5	30.5	30.5	0	0	0	0	1	1	1	0	0.0	0.0	0.0	91.6	91.6	91.6	0	0.0	0.0	0.0	91.6	91.6
CDC	LGU	0	0.0	0.0	0.0	30.5	30.5	30.5	0	0	0	0	1	1	1	0	0.0	0.0	0.0	91.6	91.6	91.6	0	0.0	0.0	0.0	91.6	91.6
LGU	SGU	0	0.0	35.8	35.8	35.8	71.5	71.5	0	0	1	1	1	1	1	0	0.0	107.3	107.3	107.3	107.3	107.3	0	0.0	107.3	107.3	107.3	107.3
SGU	LGU	0	0.0	35.8	35.8	35.8	71.5	71.5	0	0	1	1	1	1	1	0	0.0	107.3	107.3	107.3	107.3	107.3	0	0.0	107.3	107.3	107.3	107.3
SLC	CNY	0	77.1	77.1	77.1	154.2	154.2	154.2	0	1	1	1	2	2	2	0	57.8	57.8	57.8	115.6	115.6	115.6	0	57.8	57.8	57.8	57.8	57.8
CNY	SLC	0	77.1	77.1	77.1	154.2	154.2	154.2	0	1	1	1	2	2	2	0	57.8	57.8	57.8	115.6	115.6	115.6	0	57.8	57.8	57.8	57.8	57.8

Origin/ Charge Loc	Destination	Daily kWh 2024	Daily kWh 2025	Daily kWh 2026	Daily kWh 2027	Daily kWh 2028	Daily kWh 2029	Daily kWh 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030	Total Simultaneous Power (kW) 2024 WORST CASE	Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#plans/2)
CNY	DEN	0	119.3	119.3	119.3	238.5	238.5	238.5	0	1	1	1	2	2	2	0	89.5	89.5	89.5	178.9	178.9	178.9	0	89.5	89.5	89.5	89.5	89.5
DEN	CNY	0	119.3	119.3	119.3	238.5	238.5	238.5	0	1	1	1	2	2	2	0	89.5	89.5	89.5	178.9	178.9	178.9	0	89.5	89.5	89.5	89.5	89.5
PVU	CNY	0	0.0	0.0	15.4	15.4	30.8	30.8	0	0	0	1	1	1	1	0	0.0	0.0	46.2	46.2	46.2	46.2	0	0.0	0.0	46.2	46.2	46.2
CNY	PVU	0	0.0	0.0	15.4	15.4	30.8	30.8	0	0	0	1	1	1	1	0	0.0	0.0	46.2	46.2	46.2	46.2	0	0.0	0.0	46.2	46.2	46.2
OGD	CNY	0	0.0	0.0	0.0	21.7	21.7	21.7	0	0	0	0	1	1	1	0	0.0	0.0	0.0	65.1	65.1	65.1	0	0.0	0.0	0.0	65.1	65.1
CNY	OGD	0	0.0	0.0	0.0	21.7	21.7	21.7	0	0	0	0	1	1	1	0	0.0	0.0	0.0	65.1	65.1	65.1	0	0.0	0.0	0.0	65.1	65.1
SGU	CNY	0	0.0	0.0	0.0	25.0	25.0	25.0	0	0	0	0	1	1	1	0	0.0	0.0	0.0	74.9	74.9	74.9	0	0.0	0.0	0.0	74.9	74.9
CNY	SGU	0	0.0	0.0	0.0	25.0	25.0	25.0	0	0	0	0	1	1	1	0	0.0	0.0	0.0	74.9	74.9	74.9	0	0.0	0.0	0.0	74.9	74.9
LGU	CNY	0	0.0	0.0	0.0	0.0	25.0	25.0	0	0	0	0	0	1	1	0	0.0	0.0	0.0	0.0	74.9	74.9	0	0.0	0.0	0.0	0.0	74.9
CNY	LGU	0	0.0	0.0	0.0	0.0	25.0	25.0	0	0	0	0	0	1	1	0	0.0	0.0	0.0	0.0	74.9	74.9	0	0.0	0.0	0.0	0.0	74.9
SLC	SGU	0	114.4	114.4	114.4	228.8	228.8	228.8	0	1	1	1	1	1	1	0	85.8	85.8	85.8	85.8	85.8	85.8	0	85.8	85.8	85.8	85.8	85.8
SGU	SLC	0	114.4	114.4	114.4	228.8	228.8	228.8	0	1	1	1	1	1	1	0	85.8	85.8	85.8	85.8	85.8	85.8	0	85.8	85.8	85.8	85.8	85.8
SLC	CDC	0	93.1	93.1	93.1	186.2	186.2	186.2	0	1	1	1	1	1	1	0	69.8	69.8	69.8	69.8	69.8	69.8	0	69.8	69.8	69.8	69.8	69.8
CDC	SLC	0	93.1	93.1	93.1	186.2	186.2	186.2	0	1	1	1	1	1	1	0	69.8	69.8	69.8	69.8	69.8	69.8	0	69.8	69.8	69.8	69.8	69.8
CDC	KLAS~	0	16.8	33.7	33.7	50.5	50.5	67.4	0	1	1	1	1	1	1	0	50.5	50.5	50.5	50.5	50.5	50.5	0	50.5	50.5	50.5	50.5	50.5
KLAS	CDC	0	16.8	33.7	33.7	50.5	50.5	67.4	0	1	1	1	1	1	1	0	50.5	50.5	50.5	50.5	50.5	50.5	0	50.5	50.5	50.5	50.5	50.5

Origin/ Charge Loc	Destination	Daily kWh 2024	Daily kWh 2025	Daily kWh 2026	Daily kWh 2027	Daily kWh 2028	Daily kWh 2029	Daily kWh 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030	Total Simultaneous Power (kW) 2024 WORST CASE	Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#plans/2)
SGU	KLAS~	0	11.9	23.8	23.8	35.6	35.6	47.5	0	1	1	1	1	1	1	0	35.6	35.6	35.6	35.6	35.6	35.6	0	35.6	35.6	35.6	35.6	35.6
KLAS	SGU	0	11.9	23.8	23.8	35.6	35.6	47.5	0	1	1	1	1	1	1	0	35.6	35.6	35.6	35.6	35.6	35.6	0	35.6	35.6	35.6	35.6	35.6
ENV	SLC	0	11.4	22.8	34.2	45.6	45.6	45.6	0	1	1	1	1	1	1	0	34.2	34.2	34.2	34.2	34.2	34.2	0	34.2	34.2	34.2	34.2	34.2
SLC	ENV	0	11.4	22.8	34.2	45.6	45.6	45.6	0	1	1	1	1	1	1	0	34.2	34.2	34.2	34.2	34.2	34.2	0	34.2	34.2	34.2	34.2	34.2
SGU	PVU	0	0.0	25.2	25.2	50.4	50.4	50.4	0	0	1	1	1	1	1	0	0.0	75.6	75.6	75.6	75.6	75.6	0	0.0	75.6	75.6	75.6	75.6
PVU	SGU	0	0.0	25.2	25.2	50.4	50.4	50.4	0	0	1	1	1	1	1	0	0.0	75.6	75.6	75.6	75.6	75.6	0	0.0	75.6	75.6	75.6	75.6
SGU	PHX	0	82.9	82.9	110.5	110.5	110.5	110.5	0	1	1	1	2	2	2	0	82.9	82.9	82.9	165.8	165.8	165.8	0	82.9	82.9	82.9	82.9	82.9
PHX	SGU	0	82.9	82.9	110.5	110.5	110.5	110.5	0	1	1	1	2	2	2	0	82.9	82.9	82.9	165.8	165.8	165.8	0	82.9	82.9	82.9	82.9	82.9
PVU	*A	1065.83	2131.7	2131.7	4263.3	4263.3	4263.3	4263.3	5	10	10	20	20	20	20	940.44	1880.9	1880.9	3761.8	3761.8	3761.8	3761.8	470.22	940.4	940.4	1880.9	1880.9	1880.9
U42	*A	47.022	94.0	94.0	188.1	188.1	188.1	188.1	2	4	4	6	6	7	7	376.18	752.4	752.4	1128.5	1128.5	1316.6	1316.6	188.09	376.2	376.2	564.3	564.3	658.3
HCR	*A	47.022	94.0	94.0	188.1	188.1	188.1	188.1	2	4	4	6	6	7	7	376.18	752.4	752.4	1128.5	1128.5	1316.6	1316.6	188.09	376.2	376.2	564.3	564.3	658.3
NPH	*A	47.022	94.0	94.0	188.1	188.1	188.1	188.1	2	4	4	6	6	7	7	376.18	752.4	752.4	1128.5	1128.5	1316.6	1316.6	188.09	376.2	376.2	564.3	564.3	658.3
SPK	*A	47.022	94.0	94.0	188.1	188.1	188.1	188.1	2	4	4	6	6	7	7	376.18	752.4	752.4	1128.5	1128.5	1316.6	1316.6	188.09	376.2	376.2	564.3	564.3	658.3
LGU	*A	902.822	1354.2	2031.4	2708.5	3385.6	3385.6	3385.6	4	6	9	12	15	15	15	752.35	1128.5	1692.8	2257.1	2821.3	2821.3	2821.3	376.18	564.3	846.4	1128.5	1410.7	1410.7
BMC	*A	100.314	150.5	225.7	300.9	376.2	376.2	376.2	1	2	3	4	5	5	6	188.09	376.2	564.3	752.4	940.4	940.4	1128.5	188.09	188.1	282.1	376.2	470.2	470.2
CDC	*A	213.166	852.7	852.7	1705.3	2131.7	2131.7	2131.7	1	4	4	4	5	5	5	188.09	752.4	752.4	752.4	940.4	940.4	940.4	188.09	376.2	376.2	376.2	470.2	470.2
1L9	*A	37.6176	150.5	150.5	300.9	376.2	376.2	376.2	1	2	2	2	2	2	2	188.09	376.2	376.2	376.2	376.2	376.2	376.2	188.09	188.1	188.1	188.1	188.1	188.1
OGD	Layton/South HAFB*	0	0.0	0.0	70.0	70.0	140.0	140.0	0	0	0	1	1	1	1	0	0.0	0.0	105.0	105.0	105.0	105.0	0	0.0	0.0	105.0	105.0	105.0
OGD	SLC	0	0.0	0.0	198.6	397.2	595.8	595.8	0	0	0	1	2	3	3	0	0.0	0.0	149.0	297.9	446.9	446.9	0	0.0	0.0	149.0	149.0	223.4

Origin/ Charge Loc	Destination	Daily kWh 2024	Daily kWh 2025	Daily kWh 2026	Daily kWh 2027	Daily kWh 2028	Daily kWh 2029	Daily kWh 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030	Total Simultaneous Power (kW) 2024 WORST CASE	Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#plans/2)
SLC	OGD	0	0.0	0.0	198.6	397.2	595.8	595.8	0	0	0	1	2	3	3	0	0.0	0.0	149.0	297.9	446.9	446.9	0	0.0	0.0	149.0	149.0	223.4
SLC	Layton/South HAFB* to OGD	0	0.0	0.0	100.8	201.5	403.0	403.0	0	0	0	1	1	2	2	0	0.0	0.0	151.1	151.1	302.3	302.3	0	0.0	0.0	151.1	151.1	151.1
OGD	Layton/South HAFB* to SLC	0	0.0	0.0	100.8	201.5	403.0	403.0	0	0	0	1	1	2	2	0	0.0	0.0	151.1	151.1	302.3	302.3	0	0.0	0.0	151.1	151.1	151.1
SLC	City Creek* to U of U*	0	0.0	153.6	230.4	460.8	614.4	691.2	0	0	1	2	3	4	4	0	0.0	115.2	230.4	345.6	460.8	460.8	0	0.0	115.2	115.2	172.8	230.4
U42	SLC	0	0.0	0.0	87.5	174.9	349.8	437.3	0	0	0	1	1	2	3	0	0.0	0.0	131.2	131.2	262.4	393.6	0	0.0	0.0	131.2	131.2	131.2
SLC	U42	0	0.0	0.0	87.5	174.9	349.8	437.3	0	0	0	1	1	2	3	0	0.0	0.0	131.2	131.2	262.4	393.6	0	0.0	0.0	131.2	131.2	131.2
SLC	Park City*	0	0.0	99.3	198.6	397.3	595.9	695.2	0	0	1	1	2	3	4	0	0.0	149.0	149.0	298.0	446.9	595.9	0	0.0	149.0	149.0	149.0	223.5
Park City*	SLC	0	0.0	90.8	181.7	363.4	545.0	635.9	0	0	1	1	2	3	4	0	0.0	136.3	136.3	272.5	408.8	545.0	0	0.0	136.3	136.3	136.3	204.4
SLC	The Point*	0	0.0	81.2	162.3	324.6	487.0	568.1	0	0	1	1	2	3	4	0	0.0	121.7	121.7	243.5	365.2	487.0	0	0.0	121.7	121.7	121.7	182.6
The Point*	SLC	0	0.0	81.2	162.3	324.6	487.0	568.1	0	0	1	1	2	3	4	0	0.0	121.7	121.7	243.5	365.2	487.0	0	0.0	121.7	121.7	121.7	182.6
SLC	Thanksgiving Point*	0	0.0	0.0	96.3	192.5	385.0	481.3	0	0	0	1	1	2	2	0	0.0	0.0	144.4	144.4	288.8	288.8	0	0.0	0.0	144.4	144.4	144.4
Thanksgiving Point*	SLC	0	0.0	0.0	96.3	192.5	385.0	481.3	0	0	0	1	1	2	2	0	0.0	0.0	144.4	144.4	288.8	288.8	0	0.0	0.0	144.4	144.4	144.4
U42	City Creek* to U of U*	0	0.0	0.0	94.6	189.2	378.3	472.9	0	0	0	1	1	2	2	0	0.0	0.0	141.9	141.9	283.7	283.7	0	0.0	0.0	141.9	141.9	141.9
U42	The Point* to Thanksgiving Point*	0	0.0	0.0	149.7	224.6	299.4	374.3	0	0	0	1	1	2	2	0	0.0	0.0	112.3	112.3	224.6	224.6	0	0.0	0.0	112.3	112.3	112.3
U42	PVU	0	0.0	0.0	104.0	208.1	312.1	416.2	0	0	0	1	1	2	2	0	0.0	0.0	156.1	156.1	312.1	312.1	0	0.0	0.0	156.1	156.1	156.1
PVU	U42	0	0.0	0.0	104.0	208.1	312.1	416.2	0	0	0	1	1	2	2	0	0.0	0.0	156.1	156.1	312.1	312.1	0	0.0	0.0	156.1	156.1	156.1
PVU	Thanksgiving Point* to The Point*	0	0.0	0.0	90.4	180.8	180.8	271.2	0	0	0	1	1	1	2	0	0.0	0.0	135.6	135.6	135.6	271.2	0	0.0	0.0	135.6	135.6	135.6

Origin/ Charge Loc	Destination	Daily kWh 2024	Daily kWh 2025	Daily kWh 2026	Daily kWh 2027	Daily kWh 2028	Daily kWh 2029	Daily kWh 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030	Total Simultaneous Power (kW) 2024 WORST CASE	Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#plans/2)
The Point*	Thanksgiving Point* to PVU	0	0.0	0.0	90.4	180.8	180.8	271.2	0	0	0	1	1	1	2	0	0.0	0.0	135.6	135.6	135.6	271.2	0	0.0	0.0	135.6	135.6	135.6
PVU	Provo City Center* to BYU*	0	0.0	0.0	0.0	65.3	65.3	130.6	0	0	0	0	1	1	1	0	0.0	0.0	0.0	97.9	97.9	97.9	0	0.0	0.0	0.0	97.9	97.9
SLC	City Creek* to The Point*	0	0.0	0.0	351.9	351.9	527.9	791.8	0	0	0	2	2	3	4	0	0.0	0.0	263.9	263.9	395.9	527.9	0	0.0	0.0	132.0	132.0	198.0
The Point*	City Creek* to SLC	0	0.0	0.0	351.9	351.9	527.9	791.8	0	0	0	2	2	3	4	0	0.0	0.0	263.9	263.9	395.9	527.9	0	0.0	0.0	132.0	132.0	198.0
The Point*	Park City*	0	0.0	0.0	263.9	263.9	351.9	527.9	0	0	0	1	1	2	3	0	0.0	0.0	132.0	132.0	263.9	395.9	0	0.0	0.0	132.0	132.0	132.0
Park City*	The Point*	0	0.0	0.0	263.9	263.9	351.9	527.9	0	0	0	1	1	2	3	0	0.0	0.0	132.0	132.0	263.9	395.9	0	0.0	0.0	132.0	132.0	132.0
The Point*	Thanksgiving Point* to Provo City Center* to PVU	0	0.0	0.0	361.6	361.6	542.4	723.2	0	0	0	2	2	3	4	0	0.0	0.0	271.2	271.2	406.8	542.4	0	0.0	0.0	135.6	135.6	203.4
PVU	Provo City Center* to Thanksgiving Point* to The Point*	0	0.0	0.0	361.6	361.6	542.4	723.2	0	0	0	2	2	3	4	0	0.0	0.0	271.2	271.2	406.8	542.4	0	0.0	0.0	135.6	135.6	203.4
OGD	Snowbasin* to Nordic Valley* to Powder Mountain* to OGD	0	0.0	0.0	0.0	118.2	118.2	236.5	0	0	0	0	1	1	1	0	0.0	0.0	0.0	177.4	177.4	177.4	0	0.0	0.0	0.0	177.4	177.4
SLC	Snowbird/Alta Park and Ride* to Solitude/Brighton Park and Ride* to SLC	0	0.0	114.3	114.3	343.0	457.4	571.7	0	0	1	1	1	2	2	0	0.0	171.5	171.5	171.5	343.0	343.0	0	0.0	171.5	171.5	171.5	171.5
SLC	Park City*	0	0.0	99.3	99.3	298.0	397.3	496.6	0	0	1	1	1	2	2	0	0.0	149.0	149.0	149.0	298.0	298.0	0	0.0	149.0	149.0	149.0	149.0

Origin/ Charge Loc	Destination	Daily kWh 2024	Daily kWh 2025	Daily kWh 2026	Daily kWh 2027	Daily kWh 2028	Daily kWh 2029	Daily kWh 2030	# Aircraft 2024	# Aircraft 2025	# Aircraft 2026	# Aircraft 2027	# Aircraft 2028	# Aircraft 2029	# Aircraft 2030	Total Simultaneous Power (kW) 2024 WORST CASE	Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)	Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#plans/2)	Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#plans/2)
Park City*	SLC	0	0.0	99.3	99.3	298.0	397.3	496.6	0	0	1	1	1	2	2	0	0.0	149.0	149.0	149.0	298.0	298.0	0	0.0	149.0	149.0	149.0	149.0

* Electric aircraft hubs that are not located at existing airports

*A Flight school operational profiles are somewhat chaotic in nature, so instead of a certain destination, travel distance, or energy consumption per distance travelled, it is assumed that flight school aircraft use 80% of their available energy every flight.

*B The aircraft operated in AAM capacities are outlined in Section 2.4. The battery size and depth of discharge, as they are not fully defined by the aircraft developers, are substituted by a general energy consumption rate per nautical mile travelled.

Table 18. Energy required at different power rate levels required at each candidate airport for electrification (sum of daily power demand in bold for each airport, levels of power demand below totals)

Power Levels at Airport (kW)	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
1L9	**37.62**	**150.47**	**150.47**	**300.94**	**376.18**	**376.18**	**376.18**
188.09	37.62	150.47	150.47	300.94	376.18	376.18	376.18
BMC	**100.31**	**150.47**	**225.71**	**300.94**	**376.18**	**376.18**	**376.18**
188.09	100.31	150.47	225.71	300.94	376.18	376.18	376.18
BTF	**0.00**	**0.00**	**0.00**	**99.65**	**99.65**	**199.29**	**199.29**
298.94	0.00	0.00	0.00	99.65	99.65	199.29	199.29
CDC	**213.17**	**1042.32**	**1059.17**	**1911.84**	**2478.65**	**2478.65**	**2495.50**
50.55	0.00	16.85	33.70	33.70	50.55	50.55	67.39
69.82	0.00	93.09	93.09	93.09	186.18	186.18	186.18
79.72	0.00	79.72	79.72	79.72	79.72	79.72	79.72
91.64	0.00	0.00	0.00	0.00	30.55	30.55	30.55
188.09	213.17	852.67	852.67	1705.33	2131.66	2131.66	2131.66

Power Levels at Airport (kW)	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
CNY	**0.00**	**196.36**	**196.36**	**211.76**	**454.79**	**495.15**	**495.15**
46.18	0.00	0.00	0.00	15.39	15.39	30.79	30.79
57.82	0.00	77.09	77.09	77.09	154.18	154.18	154.18
65.09	0.00	0.00	0.00	0.00	21.70	21.70	21.70
74.91	0.00	0.00	0.00	0.00	24.97	49.94	49.94
89.45	0.00	119.27	119.27	119.27	238.55	238.55	238.55
DEN	**0.00**	**228.36**	**228.36**	**228.36**	**456.73**	**456.73**	**456.73**
81.82	0.00	109.09	109.09	109.09	218.18	218.18	218.18
89.45	0.00	119.27	119.27	119.27	238.55	238.55	238.55
ENV	**0.00**	**11.39**	**22.79**	**34.18**	**45.58**	**45.58**	**45.58**
34.18	0.00	11.39	22.79	34.18	45.58	45.58	45.58
HCR	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
188.09	47.02	94.04	94.04	188.09	188.09	188.09	188.09
KLAS	**0.00**	**28.73**	**57.45**	**57.45**	**86.18**	**86.18**	**114.91**
35.64	0.00	11.88	23.76	23.76	35.64	35.64	47.52
50.55	0.00	16.85	33.70	33.70	50.55	50.55	67.39
LGU	**902.82**	**1462.94**	**2295.91**	**3321.41**	**4137.78**	**4438.18**	**4438.18**
34.18	0.00	0.00	11.39	22.79	22.79	34.18	34.18
74.91	0.00	0.00	0.00	0.00	0.00	24.97	24.97
91.64	0.00	0.00	0.00	0.00	30.55	30.55	30.55
107.27	0.00	0.00	35.76	35.76	35.76	71.52	71.52
188.09	902.82	1354.23	2031.35	2708.47	3385.58	3385.58	3385.58
298.94	0.00	0.00	0.00	99.65	99.65	199.29	199.29
326.12	0.00	108.71	217.41	326.12	434.82	434.82	434.82
385.91	0.00	0.00	0.00	128.64	128.64	257.27	257.27
NPH	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
188.09	47.02	94.04	94.04	188.09	188.09	188.09	188.09
OGD	**0.00**	**0.00**	**0.00**	**369.36**	**808.66**	**1278.78**	**1397.02**
65.09	0.00	0.00	0.00	0.00	21.70	21.70	21.70

Power Levels at Airport (kW)	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
105.00	0.00	0.00	0.00	70.00	70.00	140.00	140.00
148.95	0.00	0.00	0.00	198.60	397.20	595.80	595.80
151.14	0.00	0.00	0.00	100.76	201.52	403.04	403.04
177.36	0.00	0.00	0.00	0.00	118.24	118.24	236.48
Park City*	**0.00**	**0.00**	**198.64**	**561.90**	**959.18**	**1345.12**	**1719.72**
131.97	0.00	0.00	0.00	263.94	263.94	351.92	527.88
148.98	0.00	0.00	198.64	297.96	695.24	993.20	1191.84
PHX	**0.00**	**82.91**	**82.91**	**110.55**	**110.55**	**110.55**	**110.55**
82.91	0.00	82.91	82.91	110.55	110.55	110.55	110.55
PUC	**0.00**	**134.07**	**134.07**	**134.07**	**134.07**	**134.07**	**134.07**
134.07	0.00	134.07	134.07	134.07	134.07	134.07	134.07
PVU	**1065.83**	**2131.66**	**2168.27**	**4882.76**	**5167.69**	**5479.32**	**5919.84**
34.18	0.00	0.00	11.39	22.79	22.79	34.18	34.18
46.18	0.00	0.00	0.00	15.39	15.39	30.79	30.79
75.64	0.00	0.00	25.21	25.21	50.42	50.42	50.42
97.92	0.00	0.00	0.00	0.00	65.28	65.28	130.56
135.60	0.00	0.00	0.00	452.00	542.40	723.20	994.40
156.06	0.00	0.00	0.00	104.04	208.08	312.12	416.16
188.09	1065.83	2131.66	2131.66	4263.33	4263.33	4263.33	4263.33
SGU	**0.00**	**288.93**	**361.78**	**389.41**	**925.90**	**961.66**	**973.54**
35.64	0.00	11.88	23.76	23.76	35.64	35.64	47.52
74.91	0.00	0.00	0.00	0.00	24.97	24.97	24.97
75.64	0.00	0.00	25.21	25.21	50.42	50.42	50.42
79.72	0.00	79.72	79.72	79.72	79.72	79.72	79.72
82.91	0.00	82.91	82.91	110.55	110.55	110.55	110.55
85.82	0.00	114.42	114.42	114.42	228.85	228.85	228.85
107.27	0.00	0.00	35.76	35.76	35.76	71.52	71.52
180.00	0.00	0.00	0.00	0.00	360.00	360.00	360.00
SLC	**0.00**	**418.65**	**1166.62**	**2384.46**	**6037.28**	**7692.06**	**8602.18**

Power Levels at Airport (kW)	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
21.77	0.00	0.00	21.77	21.77	21.77	21.77	21.77
25.45	0.00	0.00	25.45	25.45	25.45	25.45	25.45
27.46	0.00	0.00	27.46	27.46	27.46	27.46	27.46
34.18	0.00	11.39	22.79	34.18	45.58	45.58	45.58
41.82	0.00	13.94	27.88	41.82	55.76	55.76	55.76
57.82	0.00	77.09	77.09	77.09	154.18	154.18	154.18
69.82	0.00	93.09	93.09	93.09	186.18	186.18	186.18
85.31	0.00	0.00	0.00	0.00	170.63	170.63	170.63
85.82	0.00	114.42	114.42	114.42	228.85	228.85	228.85
115.20	0.00	0.00	153.60	230.40	460.80	614.40	691.20
121.74	0.00	0.00	81.16	162.32	324.64	486.96	568.12
121.88	0.00	0.00	0.00	0.00	243.75	243.75	243.75
131.19	0.00	0.00	0.00	87.46	174.92	349.84	437.30
131.97	0.00	0.00	0.00	351.92	351.92	527.88	791.82
136.26	0.00	0.00	90.84	181.68	363.36	545.04	635.88
142.50	0.00	0.00	0.00	0.00	285.00	285.00	285.00
144.39	0.00	0.00	0.00	96.26	192.52	385.04	481.30
148.95	0.00	0.00	0.00	198.60	397.20	595.80	595.80
148.98	0.00	0.00	99.32	99.32	297.96	397.28	496.60
150.00	0.00	0.00	0.00	0.00	300.00	300.00	300.00
151.14	0.00	0.00	0.00	100.76	201.52	403.04	403.04
153.75	0.00	0.00	0.00	0.00	307.50	307.50	307.50
171.51	0.00	0.00	114.34	114.34	343.02	457.36	571.70
221.25	0.00	0.00	0.00	0.00	442.50	442.50	442.50
326.12	0.00	108.71	217.41	326.12	434.82	434.82	434.82
SPK	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
188.09	47.02	94.04	94.04	188.09	188.09	188.09	188.09
Thanksgiving Point*	**0.00**	**0.00**	**0.00**	**96.26**	**192.52**	**385.04**	**481.30**

Power Levels at Airport (kW)	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
144.39	0.00	0.00	0.00	96.26	192.52	385.04	481.30
The Point*	**0.00**	**0.00**	**81.16**	**1230.18**	**1482.90**	**2089.96**	**2882.22**
121.74	0.00	0.00	81.16	162.32	324.64	486.96	568.12
131.97	0.00	0.00	0.00	615.86	615.86	879.80	1319.70
135.60	0.00	0.00	0.00	452.00	542.40	723.20	994.40
U42	**47.02**	**94.04**	**94.04**	**752.52**	**1113.46**	**1785.08**	**2146.02**
112.29	0.00	0.00	0.00	149.72	224.58	299.44	374.30
131.19	0.00	0.00	0.00	87.46	174.92	349.84	437.30
141.87	0.00	0.00	0.00	94.58	189.16	378.32	472.90
156.06	0.00	0.00	0.00	104.04	208.08	312.12	416.16
188.09	47.02	94.04	94.04	188.09	188.09	188.09	188.09
385.91	0.00	0.00	0.00	128.64	128.64	257.27	257.27
VEL	**0.00**	**257.10**	**271.04**	**284.98**	**625.51**	**625.51**	**625.51**
41.82	0.00	13.94	27.88	41.82	55.76	55.76	55.76
81.82	0.00	109.09	109.09	109.09	218.18	218.18	218.18
108.75	0.00	0.00	0.00	0.00	217.50	217.50	217.50
134.07	0.00	134.07	134.07	134.07	134.07	134.07	134.07

Table 19. Number of daily flights required at each candidate airport for electrification (sum of daily flights in bold for each airport, types of flights below totals)

Operation Types at Airport	Sum of Daily Flights 2024	Sum of Daily Flights 2025	Sum of Daily Flights 2026	Sum of Daily Flights 2027	Sum of Daily Flights 2028	Sum of Daily Flights 2029	Sum of Daily Flights 2030
1L9	**1**	**2**	**2**	**2**	**3**	**3**	**3**
Flight School	1	2	2	2	3	3	3
BMC	**1**	**2**	**3**	**4**	**5**	**5**	**5**
Flight School	1	2	3	4	5	5	5
BTF	**0**	**0**	**0**	**1**	**1**	**2**	**2**

Operation Types at Airport	Sum of Daily Flights 2024	Sum of Daily Flights 2025	Sum of Daily Flights 2026	Sum of Daily Flights 2027	Sum of Daily Flights 2028	Sum of Daily Flights 2029	Sum of Daily Flights 2030
Thin Haul Passenger	0	0	0	1	1	2	2
CDC	**4**	**22**	**23**	**23**	**33**	**33**	**34**
Flight School	4	16	16	16	20	20	20
Thin Haul Logistic	0	1	1	1	1	1	1
Thin Haul Passenger	0	5	6	6	12	12	13
CNY	**0**	**8**	**8**	**9**	**19**	**21**	**21**
Thin Haul Passenger	0	8	8	9	19	21	21
DEN	**0**	**8**	**8**	**8**	**16**	**16**	**16**
Thin Haul Passenger	0	8	8	8	16	16	16
ENV	**0**	**1**	**2**	**3**	**4**	**4**	**4**
Thin Haul Passenger	0	1	2	3	4	4	4
HCR	**1**	**1**	**1**	**3**	**3**	**3**	**3**
Flight School	1	1	1	3	3	3	3
KLAS	**0**	**2**	**4**	**4**	**6**	**6**	**8**
Thin Haul Passenger	0	2	4	4	6	6	8
LGU	**14**	**23**	**36**	**51**	**64**	**69**	**69**
Flight School	14	22	32	43	54	54	54
Thin Haul Passenger	0	1	4	8	10	15	15
NPH	**1**	**1**	**1**	**3**	**3**	**3**	**3**
Flight School	1	1	1	3	3	3	3
OGD	**0**	**0**	**0**	**8**	**17**	**27**	**29**
Thin Haul Passenger	0	0	0	0	1	1	1

Operation Types at Airport	Sum of Daily Flights 2024	Sum of Daily Flights 2025	Sum of Daily Flights 2026	Sum of Daily Flights 2027	Sum of Daily Flights 2028	Sum of Daily Flights 2029	Sum of Daily Flights 2030
UAM	0	0	0	8	16	26	28
Park City*	**0**	**0**	**4**	**12**	**20**	**28**	**36**
UAM	0	0	4	12	20	28	36
PHX	**0**	**3**	**3**	**4**	**4**	**4**	**4**
Thin Haul Passenger	0	3	3	4	4	4	4
PUC	**0**	**1**	**1**	**1**	**1**	**1**	**1**
Thin Haul Logistic	0	1	1	1	1	1	1
PVU	**17**	**34**	**36**	**84**	**91**	**99**	**109**
Flight School	17	34	34	68	68	68	68
Thin Haul Passenger	0	0	2	4	5	7	7
UAM	0	0	0	12	18	24	34
SGU	**0**	**9**	**12**	**13**	**22**	**23**	**24**
Thin Haul Logistic	0	1	1	1	3	3	3
Thin Haul Passenger	0	8	11	12	19	20	21
SLC	**0**	**15**	**33**	**60**	**119**	**155**	**175**
Thin Haul Logistic	0	0	3	3	15	15	15
Thin Haul Passenger	0	15	18	21	36	36	36
UAM	0	0	12	36	68	104	124
SPK	**1**	**1**	**1**	**3**	**3**	**3**	**3**
Flight School	1	1	1	3	3	3	3
Thanksgiving Point*	**0**	**0**	**0**	**2**	**4**	**8**	**10**
UAM	0	0	0	2	4	8	10
The Point*	**0**	**0**	**2**	**28**	**34**	**48**	**66**

Operation Types at Airport	Sum of Daily Flights 2024	Sum of Daily Flights 2025	Sum of Daily Flights 2026	Sum of Daily Flights 2027	Sum of Daily Flights 2028	Sum of Daily Flights 2029	Sum of Daily Flights 2030
UAM	0	0	2	28	34	48	66
U42	**1**	**1**	**1**	**14**	**22**	**35**	**43**
Flight School	1	1	1	3	3	3	3
Thin Haul Passenger	0	0	0	1	1	2	2
UAM	0	0	0	10	18	30	38
VEL	**0**	**6**	**7**	**8**	**15**	**15**	**15**
Thin Haul Logistic	0	1	1	1	3	3	3
Thin Haul Passenger	0	5	6	7	12	12	12

Table 20. Power levels required by each type of flight for electrification at each airport (sum of daily power demand in bold for each airport, levels of power demand below totals)

Operational Types at Airport by Power Demand	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
1L9	**37.62**	**150.47**	**150.47**	**300.94**	**376.18**	**376.18**	**376.18**
Flight School	**37.62**	**150.47**	**150.47**	**300.94**	**376.18**	**376.18**	**376.18**
188.088	37.62	150.47	150.47	300.94	376.18	376.18	376.18
BMC	**100.31**	**150.47**	**225.71**	**300.94**	**376.18**	**376.18**	**376.18**
Flight School	**100.31**	**150.47**	**225.71**	**300.94**	**376.18**	**376.18**	**376.18**
188.088	100.31	150.47	225.71	300.94	376.18	376.18	376.18
BTF	**0.00**	**0.00**	**0.00**	**99.65**	**99.65**	**199.29**	**199.29**
Thin Haul Passenger	**0.00**	**0.00**	**0.00**	**99.65**	**99.65**	**199.29**	**199.29**
298.9411765	0.00	0.00	0.00	99.65	99.65	199.29	199.29
CDC	**213.17**	**1042.32**	**1059.17**	**1911.84**	**2478.65**	**2478.65**	**2495.50**
Flight School	**213.17**	**852.67**	**852.67**	**1705.33**	**2131.66**	**2131.66**	**2131.66**

Operational Types at Airport by Power Demand	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
188.088	213.17	852.67	852.67	1705.33	2131.66	2131.66	2131.66
Thin Haul Logistic	**0.00**	**79.72**	**79.72**	**79.72**	**79.72**	**79.72**	**79.72**
79.71764706	0.00	79.72	79.72	79.72	79.72	79.72	79.72
Thin Haul Passenger	**0.00**	**109.94**	**126.79**	**126.79**	**267.27**	**267.27**	**284.12**
50.54545455	0.00	16.85	33.70	33.70	50.55	50.55	67.39
69.81818182	0.00	93.09	93.09	93.09	186.18	186.18	186.18
91.63636364	0.00	0.00	0.00	0.00	30.55	30.55	30.55
CNY	**0.00**	**196.36**	**196.36**	**211.76**	**454.79**	**495.15**	**495.15**
Thin Haul Passenger	**0.00**	**196.36**	**196.36**	**211.76**	**454.79**	**495.15**	**495.15**
46.18181818	0.00	0.00	0.00	15.39	15.39	30.79	30.79
57.81818182	0.00	77.09	77.09	77.09	154.18	154.18	154.18
65.09090909	0.00	0.00	0.00	0.00	21.70	21.70	21.70
74.90909091	0.00	0.00	0.00	0.00	24.97	49.94	49.94
89.45454545	0.00	119.27	119.27	119.27	238.55	238.55	238.55
DEN	**0.00**	**228.36**	**228.36**	**228.36**	**456.73**	**456.73**	**456.73**
Thin Haul Passenger	**0.00**	**228.36**	**228.36**	**228.36**	**456.73**	**456.73**	**456.73**
81.81818182	0.00	109.09	109.09	109.09	218.18	218.18	218.18
89.45454545	0.00	119.27	119.27	119.27	238.55	238.55	238.55
ENV	**0.00**	**11.39**	**22.79**	**34.18**	**45.58**	**45.58**	**45.58**
Thin Haul Passenger	**0.00**	**11.39**	**22.79**	**34.18**	**45.58**	**45.58**	**45.58**
34.18181818	0.00	11.39	22.79	34.18	45.58	45.58	45.58
HCR	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
Flight School	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
188.088	47.02	94.04	94.04	188.09	188.09	188.09	188.09
KLAS	**0.00**	**28.73**	**57.45**	**57.45**	**86.18**	**86.18**	**114.91**
Thin Haul Passenger	**0.00**	**28.73**	**57.45**	**57.45**	**86.18**	**86.18**	**114.91**
35.63636364	0.00	11.88	23.76	23.76	35.64	35.64	47.52
50.54545455	0.00	16.85	33.70	33.70	50.55	50.55	67.39
LGU	**902.82**	**1462.94**	**2295.91**	**3321.41**	**4137.78**	**4438.18**	**4438.18**

Operational Types at Airport by Power Demand	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
Flight School	**902.82**	**1354.23**	**2031.35**	**2708.47**	**3385.58**	**3385.58**	**3385.58**
188.088	902.82	1354.23	2031.35	2708.47	3385.58	3385.58	3385.58
Thin Haul Passenger	**0.00**	**108.71**	**264.56**	**612.95**	**752.20**	**1052.60**	**1052.60**
34.18181818	0.00	0.00	11.39	22.79	22.79	34.18	34.18
74.90909091	0.00	0.00	0.00	0.00	0.00	24.97	24.97
91.63636364	0.00	0.00	0.00	0.00	30.55	30.55	30.55
107.2727273	0.00	0.00	35.76	35.76	35.76	71.52	71.52
298.9411765	0.00	0.00	0.00	99.65	99.65	199.29	199.29
326.1176471	0.00	108.71	217.41	326.12	434.82	434.82	434.82
385.9058824	0.00	0.00	0.00	128.64	128.64	257.27	257.27
NPH	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
Flight School	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
188.088	47.02	94.04	94.04	188.09	188.09	188.09	188.09
OGD	**0.00**	**0.00**	**0.00**	**369.36**	**808.66**	**1278.78**	**1397.02**
Thin Haul Passenger	**0.00**	**0.00**	**0.00**	**0.00**	**21.70**	**21.70**	**21.70**
65.09090909	0.00	0.00	0.00	0.00	21.70	21.70	21.70
UAM	**0.00**	**0.00**	**0.00**	**369.36**	**786.96**	**1257.08**	**1375.32**
105	0.00	0.00	0.00	70.00	70.00	140.00	140.00
148.95	0.00	0.00	0.00	198.60	397.20	595.80	595.80
151.14	0.00	0.00	0.00	100.76	201.52	403.04	403.04
177.36	0.00	0.00	0.00	0.00	118.24	118.24	236.48
Park City*	**0.00**	**0.00**	**198.64**	**561.90**	**959.18**	**1345.12**	**1719.72**
UAM	**0.00**	**0.00**	**198.64**	**561.90**	**959.18**	**1345.12**	**1719.72**
131.97	0.00	0.00	0.00	263.94	263.94	351.92	527.88
148.98	0.00	0.00	198.64	297.96	695.24	993.20	1191.84
PHX	**0.00**	**82.91**	**82.91**	**110.55**	**110.55**	**110.55**	**110.55**
Thin Haul Passenger	**0.00**	**82.91**	**82.91**	**110.55**	**110.55**	**110.55**	**110.55**
82.90909091	0.00	82.91	82.91	110.55	110.55	110.55	110.55
PUC	**0.00**	**134.07**	**134.07**	**134.07**	**134.07**	**134.07**	**134.07**

Operational Types at Airport by Power Demand	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
Thin Haul Logistic	**0.00**	**134.07**	**134.07**	**134.07**	**134.07**	**134.07**	**134.07**
134.0705882	0.00	134.07	134.07	134.07	134.07	134.07	134.07
PVU	**1065.83**	**2131.66**	**2168.27**	**4882.76**	**5167.69**	**5479.32**	**5919.84**
Flight School	**1065.83**	**2131.66**	**2131.66**	**4263.33**	**4263.33**	**4263.33**	**4263.33**
188.088	1065.83	2131.66	2131.66	4263.33	4263.33	4263.33	4263.33
Thin Haul Passenger	**0.00**	**0.00**	**36.61**	**63.39**	**88.61**	**115.39**	**115.39**
34.18181818	0.00	0.00	11.39	22.79	22.79	34.18	34.18
46.18181818	0.00	0.00	0.00	15.39	15.39	30.79	30.79
75.63636364	0.00	0.00	25.21	25.21	50.42	50.42	50.42
UAM	**0.00**	**0.00**	**0.00**	**556.04**	**815.76**	**1100.60**	**1541.12**
97.92	0.00	0.00	0.00	0.00	65.28	65.28	130.56
135.6	0.00	0.00	0.00	452.00	542.40	723.20	994.40
156.06	0.00	0.00	0.00	104.04	208.08	312.12	416.16
SGU	**0.00**	**288.93**	**361.78**	**389.41**	**925.90**	**961.66**	**973.54**
Thin Haul Logistic	**0.00**	**79.72**	**79.72**	**79.72**	**439.72**	**439.72**	**439.72**
79.71764706	0.00	79.72	79.72	79.72	79.72	79.72	79.72
180	0.00	0.00	0.00	0.00	360.00	360.00	360.00
Thin Haul Passenger	**0.00**	**209.21**	**282.06**	**309.70**	**486.18**	**521.94**	**533.82**
35.63636364	0.00	11.88	23.76	23.76	35.64	35.64	47.52
74.90909091	0.00	0.00	0.00	0.00	24.97	24.97	24.97
75.63636364	0.00	0.00	25.21	25.21	50.42	50.42	50.42
82.90909091	0.00	82.91	82.91	110.55	110.55	110.55	110.55
85.81818182	0.00	114.42	114.42	114.42	228.85	228.85	228.85
107.2727273	0.00	0.00	35.76	35.76	35.76	71.52	71.52
SLC	**0.00**	**418.65**	**1166.62**	**2384.46**	**6037.28**	**7692.06**	**8602.18**
Thin Haul Logistic	**0.00**	**0.00**	**74.68**	**74.68**	**1824.05**	**1824.05**	**1824.05**
21.76744186	0.00	0.00	21.77	21.77	21.77	21.77	21.77
25.45116279	0.00	0.00	25.45	25.45	25.45	25.45	25.45
27.46046512	0.00	0.00	27.46	27.46	27.46	27.46	27.46

Operational Types at Airport by Power Demand	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
85.3125	0.00	0.00	0.00	0.00	170.63	170.63	170.63
121.875	0.00	0.00	0.00	0.00	243.75	243.75	243.75
142.5	0.00	0.00	0.00	0.00	285.00	285.00	285.00
150	0.00	0.00	0.00	0.00	300.00	300.00	300.00
153.75	0.00	0.00	0.00	0.00	307.50	307.50	307.50
221.25	0.00	0.00	0.00	0.00	442.50	442.50	442.50
Thin Haul Passenger	**0.00**	**418.65**	**552.68**	**686.72**	**1105.37**	**1105.37**	**1105.37**
34.18181818	0.00	11.39	22.79	34.18	45.58	45.58	45.58
41.81818182	0.00	13.94	27.88	41.82	55.76	55.76	55.76
57.81818182	0.00	77.09	77.09	77.09	154.18	154.18	154.18
69.81818182	0.00	93.09	93.09	93.09	186.18	186.18	186.18
85.81818182	0.00	114.42	114.42	114.42	228.85	228.85	228.85
326.1176471	0.00	108.71	217.41	326.12	434.82	434.82	434.82
UAM	**0.00**	**0.00**	**539.26**	**1623.06**	**3107.86**	**4762.64**	**5672.76**
115.2	0.00	0.00	153.60	230.40	460.80	614.40	691.20
121.74	0.00	0.00	81.16	162.32	324.64	486.96	568.12
131.19	0.00	0.00	0.00	87.46	174.92	349.84	437.30
131.97	0.00	0.00	0.00	351.92	351.92	527.88	791.82
136.26	0.00	0.00	90.84	181.68	363.36	545.04	635.88
144.39	0.00	0.00	0.00	96.26	192.52	385.04	481.30
148.95	0.00	0.00	0.00	198.60	397.20	595.80	595.80
148.98	0.00	0.00	99.32	99.32	297.96	397.28	496.60
151.14	0.00	0.00	0.00	100.76	201.52	403.04	403.04
171.51	0.00	0.00	114.34	114.34	343.02	457.36	571.70
SPK	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
Flight School	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
188.088	47.02	94.04	94.04	188.09	188.09	188.09	188.09
Thanksgiving Point*	**0.00**	**0.00**	**0.00**	**96.26**	**192.52**	**385.04**	**481.30**
UAM	**0.00**	**0.00**	**0.00**	**96.26**	**192.52**	**385.04**	**481.30**

Operational Types at Airport by Power Demand	Sum of Daily kWh 2024	Sum of Daily kWh 2025	Sum of Daily kWh 2026	Sum of Daily kWh 2027	Sum of Daily kWh 2028	Sum of Daily kWh 2029	Sum of Daily kWh 2030
144.39	0.00	0.00	0.00	96.26	192.52	385.04	481.30
The Point*	**0.00**	**0.00**	**81.16**	**1230.18**	**1482.90**	**2089.96**	**2882.22**
UAM	**0.00**	**0.00**	**81.16**	**1230.18**	**1482.90**	**2089.96**	**2882.22**
121.74	0.00	0.00	81.16	162.32	324.64	486.96	568.12
131.97	0.00	0.00	0.00	615.86	615.86	879.80	1319.70
135.6	0.00	0.00	0.00	452.00	542.40	723.20	994.40
U42	**47.02**	**94.04**	**94.04**	**752.52**	**1113.46**	**1785.08**	**2146.02**
Flight School	**47.02**	**94.04**	**94.04**	**188.09**	**188.09**	**188.09**	**188.09**
188.088	47.02	94.04	94.04	188.09	188.09	188.09	188.09
Thin Haul Passenger	**0.00**	**0.00**	**0.00**	**128.64**	**128.64**	**257.27**	**257.27**
385.9058824	0.00	0.00	0.00	128.64	128.64	257.27	257.27
UAM	**0.00**	**0.00**	**0.00**	**435.80**	**796.74**	**1339.72**	**1700.66**
112.29	0.00	0.00	0.00	149.72	224.58	299.44	374.30
131.19	0.00	0.00	0.00	87.46	174.92	349.84	437.30
141.87	0.00	0.00	0.00	94.58	189.16	378.32	472.90
156.06	0.00	0.00	0.00	104.04	208.08	312.12	416.16
VEL	**0.00**	**257.10**	**271.04**	**284.98**	**625.51**	**625.51**	**625.51**
Thin Haul Logistic	**0.00**	**134.07**	**134.07**	**134.07**	**351.57**	**351.57**	**351.57**
108.75	0.00	0.00	0.00	0.00	217.50	217.50	217.50
134.0705882	0.00	134.07	134.07	134.07	134.07	134.07	134.07
Thin Haul Passenger	**0.00**	**123.03**	**136.97**	**150.91**	**273.94**	**273.94**	**273.94**
41.81818182	0.00	13.94	27.88	41.82	55.76	55.76	55.76
81.81818182	0.00	109.09	109.09	109.09	218.18	218.18	218.18

Table 21. Power requirements at each airport assuming simultaneous charge of up to two aircraft

Airport Code	Sum of Total Simultaneous Power (kW) 2025 MIDDLE CASE (P*#aircraft/2)	Sum of Total Simultaneous Power (kW) 2026 MIDDLE CASE (P*#aircraft/2)	Sum of Total Simultaneous Power (kW) 2027 MIDDLE CASE (P*#aircraft/2)	Sum of Total Simultaneous Power (kW) 2028 MIDDLE CASE (P*#aircraft/2)	Sum of Total Simultaneous Power (kW) 2029 MIDDLE CASE (P*#aircraft/2)	Sum of Total Simultaneous Power (kW) 2030 MIDDLE CASE (P*#aircraft/2)
1L9	188.09	188.09	188.09	188.09	188.09	188.09
BMC	188.09	188.09	282.13	376.18	470.22	470.22
BTF	0.00	0.00	0.00	298.94	298.94	298.94
CDC	188.09	576.26	576.26	576.26	761.94	761.94
CNY	0.00	147.27	147.27	193.45	333.45	408.36
DEN	0.00	171.27	171.27	171.27	171.27	171.27
ENV	0.00	34.18	34.18	34.18	34.18	34.18
HCR	188.09	376.18	376.18	564.26	564.26	658.31
KLAS	0.00	86.18	86.18	86.18	86.18	86.18
LGU	376.18	890.38	1313.97	2280.95	2654.72	2729.62
NPH	188.09	376.18	376.18	564.26	564.26	658.31
OGD	0.00	0.00	0.00	405.09	647.54	722.02
Park City*	0.00	0.00	297.96	429.93	429.93	504.42
PHX	0.00	82.91	82.91	82.91	82.91	82.91
PUC	0.00	134.07	134.07	134.07	134.07	134.07
PVU	470.22	940.44	1050.26	2464.14	2562.06	2629.86
SGU	0.00	284.08	466.99	466.99	721.90	721.90
SLC	0.00	615.57	1383.94	2091.58	3023.87	3350.93
SPK	188.09	376.18	376.18	564.26	564.26	658.31
Thanksgiving Point*	0.00	0.00	0.00	144.39	144.39	144.39
The Point*	0.00	0.00	121.74	656.88	656.88	851.54
U42	188.09	376.18	376.18	1491.58	1491.58	1585.62
VEL	0.00	257.71	257.71	257.71	366.46	366.46

Table 22. Power requirements at each airport assuming simultaneous charge of all aircraft at each airport

Airport Code	Sum of Total Simultaneous Power (kW) 2024 WORST CASE	Sum of Total Simultaneous Power (kW) 2025 WORST CASE (all aircraft charging in parallel)	Sum of Total Simultaneous Power (kW) 2026 WORST CASE (all aircraft charging in parallel)	Sum of Total Simultaneous Power (kW) 2027 WORST CASE (all aircraft charging in parallel)	Sum of Total Simultaneous Power (kW) 2028 WORST CASE (all aircraft charging in parallel)	Sum of Total Simultaneous Power (kW) 2029 WORST CASE (all aircraft charging in parallel)	Sum of Total Simultaneous Power (kW) 2030 WORST CASE (all aircraft charging in parallel)
1L9	188.09	376.18	376.18	376.18	376.18	376.18	376.18
BMC	188.09	376.18	564.26	752.35	940.44	940.44	1128.53
BTF	0.00	0.00	0.00	298.94	298.94	298.94	298.94
CDC	188.09	952.43	952.43	952.43	1232.16	1232.16	1232.16
CNY	0.00	147.27	147.27	193.45	480.73	555.64	555.64
DEN	0.00	171.27	171.27	171.27	342.55	342.55	342.55
ENV	0.00	34.18	34.18	34.18	34.18	34.18	34.18
HCR	376.18	752.35	752.35	1128.53	1128.53	1316.62	1316.62
KLAS	0.00	86.18	86.18	86.18	86.18	86.18	86.18
LGU	752.35	1454.65	2160.36	3409.48	4065.38	4140.28	4140.28
NPH	376.18	752.35	752.35	1128.53	1128.53	1316.62	1316.62
OGD	0.00	0.00	0.00	405.09	796.49	1096.58	1096.58
Park City*	0.00	0.00	297.96	429.93	578.91	1008.84	1289.79
PHX	0.00	82.91	82.91	82.91	165.82	165.82	165.82
PUC	0.00	134.07	134.07	134.07	134.07	134.07	134.07
PVU	940.44	1880.88	1990.70	4480.62	4578.54	4870.20	5141.40
SGU	0.00	284.08	466.99	466.99	984.81	984.81	984.81
SLC	0.00	615.57	1383.94	2338.75	4668.09	6069.42	6590.58
SPK	376.18	752.35	752.35	1128.53	1128.53	1316.62	1316.62
Thanksgiving Point*	0.00	0.00	0.00	144.39	144.39	288.78	288.78
The Point*	0.00	0.00	121.74	924.45	1046.19	1567.47	2224.35
U42	376.18	752.35	752.35	2055.84	2055.84	2785.34	2916.53
VEL	0.00	257.71	257.71	257.71	557.03	557.03	557.03

APPENDIX B: U-SWEAP Framework

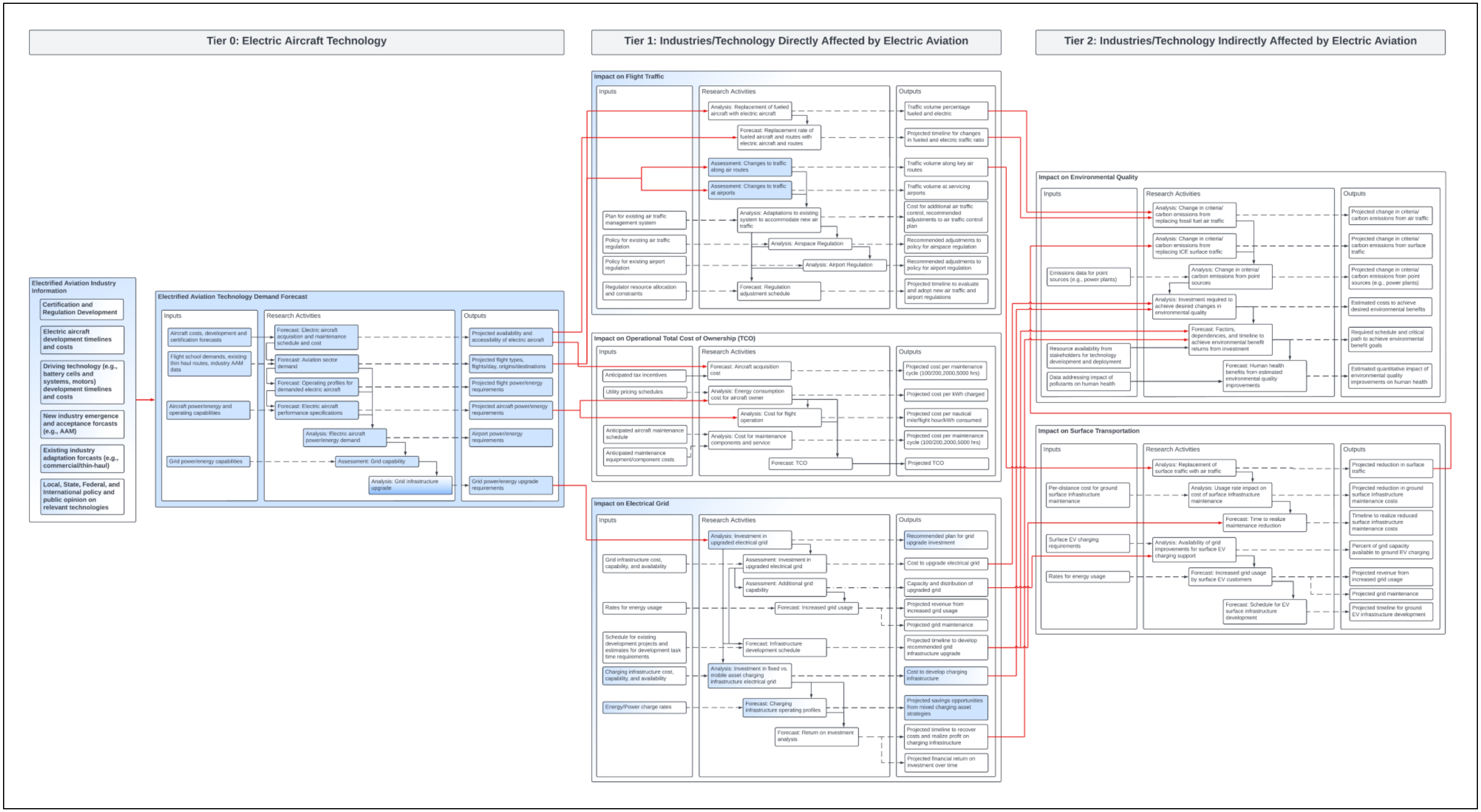

Figure 21. Full U-SWEAP Framework