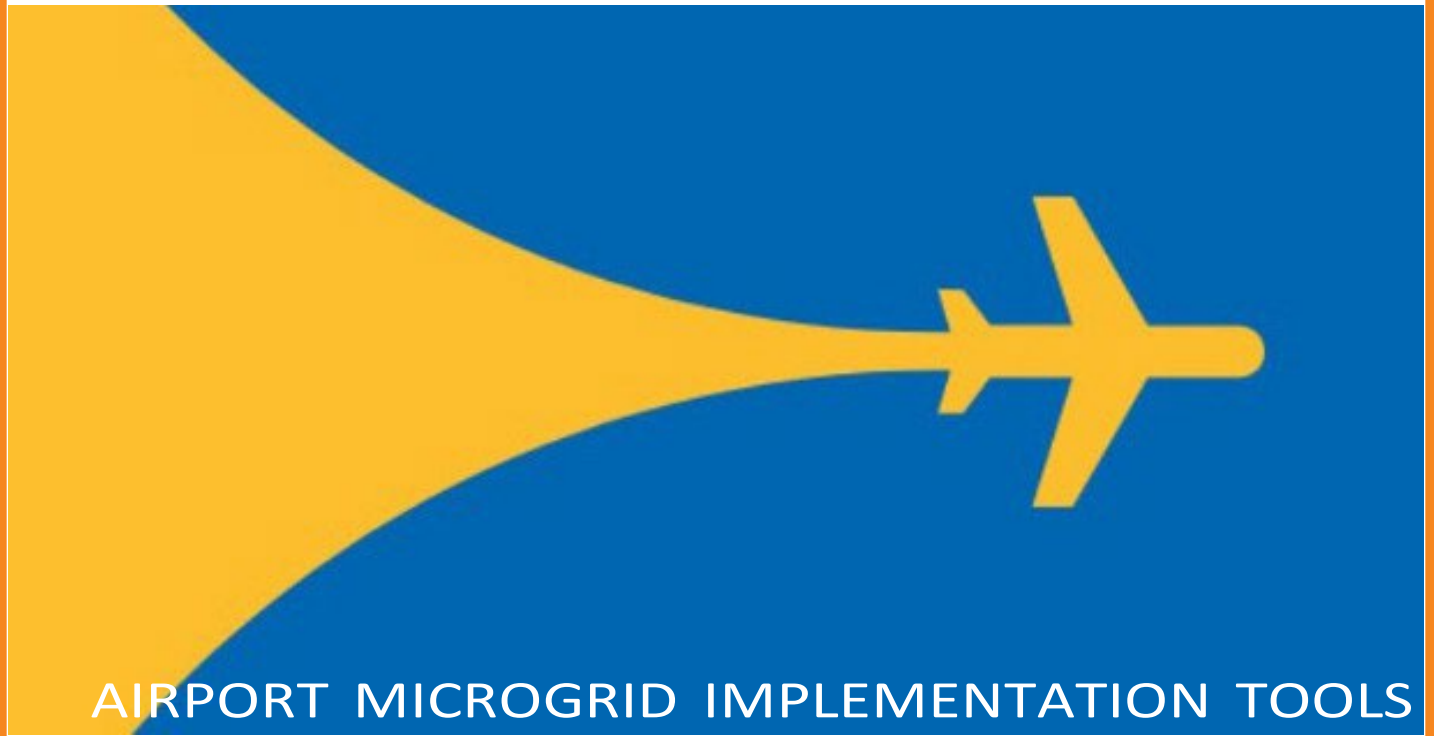


ACRP

AIRPORT
COOPERATIVE
RESEARCH
PROGRAM



AIRPORT MICROGRID IMPLEMENTATION TOOLS

USER GUIDE

AIRPORT MICROGRID IMPLEMENTATION TOOLS

INTRODUCTION

Rocky Mountain Institute (RMI) led a multi-firm project team to develop Airport Microgrid Implementation Tools (AMIT). The Airport Cooperative Research Program (ACRP) funded a project to better equip airports to increase their resilience and avoid the disruptive impacts associated with electrical power loss. Airport vulnerability due to power outages, which are potentially increasing in frequency and duration, cause significant industry costs and impact passenger confidence in air travel. RMI has developed a web-based resource to inform airport stakeholders about the capabilities of microgrids and guidance regarding whether an installation might benefit a specific location. The development of the AMIT was enhanced with two in-person workshops conducted at Ithaca- Tompkins and Massport's Hanscom airports.

AMIT users can upload specific airport data and obtain microgrid information and recommendations from the AMIT's eight modules. The AMIT information is based on 2017 data and statistics. Use the information provided as suggestions for updating a project airport's microgrid readiness and efficiency.

This AMIT User Guide describes the navigation tools and outlines the eight AMIT modules. Use it as a reference to understand how the airport information entered influences the recommendations for developing and improving an airport microgrid.

AIRPORT MICROGRID IMPLEMENTATION TOOLS

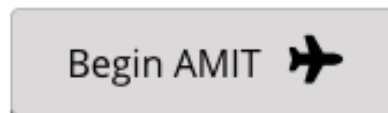
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NAVIGATING THE AMIT

The main menu at the top of the screen is available throughout the AMIT. At any point, the user may access any of the main pages.



“Home” - The *Home* page is where the user will begin the modules and begin a new airport project or upload information from a previous project that needs to be completed.



Do not open modules in a new tab. Opening a module in a new tab will start a new project session.

Do not skip ahead in the AMIT unless directed to do so. Skipping ahead may result in an incomplete summary report.

“Contents” - The *Contents* page describes the foundation for the AMIT program and gives a brief overview of each module in the AMIT.

“About” - The development and programming of the AMIT included the collaboration of several organizations. The *About* page introduces the organization that contributed to the development of the AMIT.

“Glossary” - There are several terms and acronyms that are unique to microgrid development. The *Glossary* page lists important universal terms and organizations that are mentioned throughout the AMIT. You can refer to it throughout the modules.

“User Guide” - The User Guide is available to view online and can also be downloaded. It provides directions and important notes for each page and module of the AMIT.

“Feedback” - The AMIT is designed to be a user-friendly guide to assist in airport readiness. ACRP values feedback. If you have any suggestions or thoughts about AMIT, send them to ACRP by emailing acrp@nas.edu.


“Exit AMIT” - The *Exit AMIT* page guides the user through saving their project information and exiting the AMIT.

Exit AMIT

If you are ending your session before downloading your completed summary report, download your progress. You can upload your incomplete project when you return and resume the AMIT where you ended your last session.

If you have finished your session, you may close your browser after you have downloaded your current project.

Click "Start a New Project" to erase your current project data and begin a new session.

 Start New Project

 Save AMIT Progress

At any point during a module, the user may choose to save their work and continue at a later time. As the user completes each module, their project information and progress are temporarily saved by the AMIT system. Before exiting the AMIT, the user should click the "Save AMIT Progress" button to download their project information.

 Save AMIT Progress

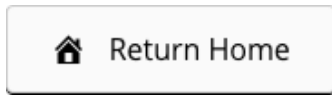
When the user returns to the AMIT, they can continue their project by uploading the project file. The AMIT will automatically open to the last completed page.

Click or Drag and Drop here to upload AMIT project file.

If the user does not download their project before exiting the AMIT, they will need to begin a new project.

The user is not required to save their project.

NAVIGATING THE AMIT



At any point in the AMIT, the user can return to the *Home* page by clicking “Home” on the main menu bar or by clicking the “Return Home” button.



The “Previous Page” button will always return the user to the previous page in the module.



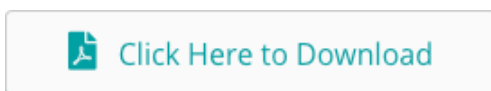
The “Continue” button will move the user through the AMIT modules. Project progress is monitored, and the data is automatically saved until the user exits the AMIT.



The user should click the “Save AMIT Progress” button to save and download their current airport project should they need to exit the AMIT before completing Module 7. If the user exits the AMIT without saving their information, it will be deleted when the user exits the AMIT.



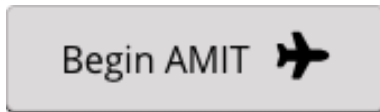
Begin Module “X” is on every *Summary* page. Click this button to begin the next module.



Downloadable reference material is available throughout the AMIT. Some of the material can be downloaded by the user. Click the download button to save a PDF version of the referenced material.

AMIT PROJECTS

BEGIN A NEW PROJECT



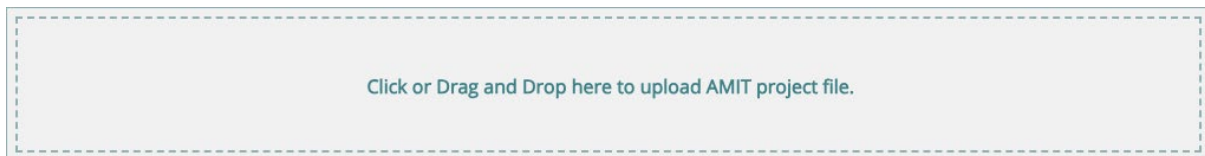
To begin a new AMIT project, click the “Begin AMIT” button on the Home page.

This will open Module 0 - Microgrid Basics & Background.

RESUME AN EXISTING PROJECT

To resume a project, upload the saved Project Progress file. *(Uploading a saved project will overwrite any current information that has been entered.)*

Once the project has been uploaded, the user will be able to resume their project at the module where their last session ended. There is no limit on the number of times a user may save and resume their project. It is important for the user to provide as much accurate information about their airport as possible to have the most comprehensive final report.



Certain sections of the AMIT request airport-specific information. It is important that the information provided is accurate for the AMIT to produce the best microgrid suggestions.

The * system below notates how the airport information provided will be used in the AMIT.

(*) - This input impacts other input/output in the AMIT.

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MODULE 0

MICROGRID BASICS AND BACKGROUNDS

MODULE ZERO

Introduction

Module 0 contains general education and guidance on airport microgrids to ensure a base level of understanding before launching into the remaining modules. On the *Introduction* page, click on the video and read through each module description to gain a sense of the AMIT contents.

Module 0

Introduction

Common Terms

What is a Microgrid

Case Examples

Microgrid Design Process

Tools

Additional Information

Summary

Skip Background

Save AMIT Progress

Introduction: Microgrid Basics & Background

Welcome to the Airport Microgrid Implementation Toolkit. This toolkit is divided into eight modules, or topic areas, to guide you with airport microgrid project development.

Module 0
Microgrid Basics & Background

Introduction

Common Terms

What is a Microgrid

Case Examples

Microgrid Design Process

Tools

Additional Information

Summary

Return to Dashboard

Microgrid Basics & Background

Welcome to the Airport Microgrid Implementation Toolkit. This toolkit is divided into eight modules, or topic areas, to guide you with airport microgrid project development.

- **Module 0, Microgrid Basics & Background:** contains general education and guidance on airport microgrids to ensure a base-level of understanding before launching into the tool.
- **Module 1, Airport Profile:** will help you understand airport energy supply and usage data as well as how airport location and corresponding utility characteristics may affect microgrid development.
- **Module 2, Resilience or Risk:** identifies potential risks that are the priority to be kept in mind in the event of an outage, and helps you better understand your airport's vulnerability and preparedness for utility outages and other considerations such as cyber security.
- **Module 3, Stakeholder Engagement:** will cover the range of stakeholders involved in microgrid development and provide educational materials and recommendations to conduct effective stakeholder management.
- **Module 4, Energy Options:** provides the benefits and tradeoffs of different energy technologies that could be used in a microgrid such as solar, emissions, resilience, siting considerations, etc.
- **Module 5, Finance & Ownership:** will explain the different options, benefits, and tradeoffs for financing energy projects as well as various ownership models, funding sources, tariffs and user agreements, benefits, costs, business case analysis, and procurement guidance for microgrids.
- **Module 6, Operations & Maintenance:** will help you understand Operations and Maintenance (O&M) considerations for microgrids and identify considerations for integrating microgrid or energy systems operators with airport systems.
- **Module 7, Master Module:** will summarize the results and outputs generated by working through the previous modules, provide a recommended sequence of actions for procurement and design, and data requirements.

00:00 01:40

AMIT users with a background in microgrid technologies may consider moving forward to Module 1 - Airport Profile. If this is the case, click the “Skip Background” button on the *Introduction* page of Module 0.

Users unfamiliar with microgrids should continue through all lessons in Module 0.

Common Terms

Review the list of acronyms and terms that are referenced throughout the AMIT. If you come across an unfamiliar term in the AMIT, refer to the Glossary located on the main menu.

HOME

CONTENTS

ABOUT

GLOSSARY

USER GUIDE

FEEDBACK

EXIT AMIT

MODULE 0

MICROGRID BASICS AND BACKGROUNDS

What is a Microgrid

The *What is a Microgrid?* page provides a well-accepted microgrid definition provided by the Department of Energy:

A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. It can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

Read through the definitions and supporting material, including the list of microgrid benefits. With a better understanding of microgrids, click the “Continue” button and proceed to the *Case Examples* page to see how microgrids have been put into practice at airports.

Case Examples

The *Case Examples* section of the module includes six airport microgrid case studies; five military airbase microgrids and one civilian airport microgrid. Click on a link and read through each case study for details related to microgrid technologies, capabilities, sources of funding, project timeline, and more. At the bottom of each case study, click the “Back” button to return to the *Case Examples* page. After reading through the case studies, click the “Continue” button to proceed through the module.

Microgrid Design Process

The *Microgrid Design Process* page details a 10-stage framework for microgrid design and implementation developed under **ACRP Synthesis 91/TCRP Synthesis 137: Microgrids and Their Application for Airports and Public Transit**. Explore the design process diagram and then navigate down to the “How Does the AMIT Fit In” section. Read through each module description.

Tools

The *Tools* page introduces the phases of microgrid adoption and provides information on techno-economic models and power system analysis tools that can be used during the planning and design phases. A comprehensive list of techno-economic and power system analysis tools is available through a variety of providers included in the AMIT.

MODULE 0

MICROGRID BASICS AND BACKGROUNDS

Additional Information

Explore additional microgrid resources prior to moving on, the *Additional Information* page includes a number of links to resources ranging from microgrid design and implementation to resiliency and monetization.

Summary

Review the information learned in Module 0. A red “X” indicates an incomplete lesson in the module. If critical information is missing, it will impact the final report. Review incomplete modules before moving forward.

Summary: Microgrid Basics & Background

You have completed Module 0: Microgrid Basics & Background.

Tasks for Module 0

- ✓ Review Microgrid Basics & Background
- ✓ Review Common Terms
- ✓ Review What is a Microgrid
- ✓ Review Case Examples
- ✓ Review Microgrid Design Processes
- ✓ Review Microgrid Assessment Tools
- ✓ Review Additional Information

A green check mark indicates a successfully completed lesson. Click the “Begin Module 1” button to continue through the AMIT.

*The * system below notates how the airport information provided will be used in the AMIT.*

() - This input impacts other input/output in the AMIT.*

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*(***) - This is an output based on user input(s). Mod 1 Summary Page*

MODULE 1

AIRPORT PROFILE

MODULE ONE

Introduction

Module 1 is intended to help the user understand how airport location and the corresponding electric utility characteristics may influence microgrid project development. It will also help familiarize the user with airport energy supply and usage data. On the *Introduction* page, click on the video and read through the introduction. Then click the “Continue” button to proceed to the next lesson.

Module 1

Module 1 – Airport Profile Introduction

Module 1 – Airport Information

Module 1 – Energy Use

Module 1 – Load Profile Summary

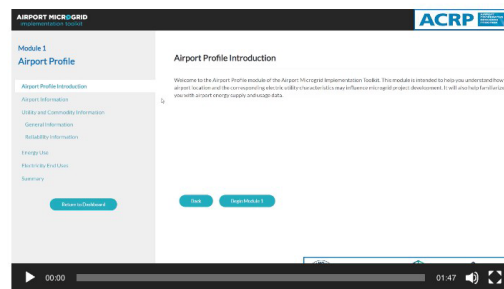
Module 1 – Electricity End Uses

Module 1 – Summary

Save AMIT Progress

Introduction: Airport Profile

Welcome to the Airport Profile module of the Airport Microgrid Implementation Toolkit. This module is intended to help you understand how airport location and the corresponding electric utility characteristics may influence microgrid project development. It will also help familiarize you with airport energy supply and usage data.



Airport Information

On the *Airport Information* page, the user should enter the International Air Transport Association (IATA) 3 or 4-letter identifier in the dropdown menu and click their project facility from the list.* Verify the facility name and location on the associated map and then click the “Continue” button at the bottom of the page to continue through the module.

Airport Code (IATA)

Facility Name

Baltimore/Washington Intl Thurgood Marshall

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MODULE 1

AIRPORT PROFILE

Utility and Commodity Information

The next step is to enter information about the utility provider(s) for the project facility. First, click the airport's Electric Utility Provider using the dropdown list.* The dropdown list includes all of the electric utility providers registered in the airport's state (*based on your previously entered airport code*).

Electric Utility Provider

Electric Utility Tariff Name

Next, enter the Electric Utility Tariff Name.** Consult a monthly utility bill to find the precise name of the utility tariff, then enter it in the text box. If the utility bill is unavailable, or the utility tariff on the bill can't be located, enter **Unknown** in the text box.

Next, if the airport generates heat or electricity from fuel such as diesel or natural gas, enter the name and fee schedule of the commodity provider in the appropriate text boxes.

Leave the Commodity Provider Name field blank if the facility does not purchase fuel to deliver heat or to generate electricity.** If the electric utility is the same company that provides these commodities, then enter **Same**.

Leave the Commodity Fee Schedule field blank if the facility does not purchase fuel to deliver heat or to generate electricity.** Otherwise, consult the monthly commodity bill to find the precise name of the fee schedule, then enter it in the text box. If the commodity bill is unavailable or the fee schedule can't be located on the facility bill, enter **Unknown** in the text box.

Once all applicable utility/commodity provider inputs have been entered, click the "Continue" button to move on through the AMIT. The next section presents general and reliability information about utility providers.

MODULE 1

AIRPORT PROFILE

Energy Use

In this section, the user clicks how they would like to enter your airport's energy use. The options for entering this information are by: (1) uploading the airport's hourly energy load profile; (2) entering the airport's monthly energy use and peak demand; or (3) by clicking an energy load profile from a sample airport. Click the option desired and click the "Continue" button.

Uploading your airport's hourly energy load profile will provide the best results.

- Upload your airport's hourly energy load profile
- Enter your airport's monthly energy consumption (MWh) and peak load (kW)
- Use the energy load profile data from a sample airport

(You must select an answer to move forward in the AMIT.)

Option 1: Upload Your Airport's Hourly Energy Load Profile

Uploading the airport's hourly energy load profile will provide the best results. To upload the airport's hourly energy load profile, first download the appropriate "Airport Load Profile Data Template" spreadsheet, open the spreadsheet, and then follow the instructions to save and upload the spreadsheet to the AMIT. Click the "Continue" button to view and download the following charts: Winter Weekday, Peak kilowatt (kW), Summer Weekday, Peak (kW), Peak Day, and Frequency of Daily Peak Loads.

Option 2: Enter the Airport's Monthly Energy Consumption (MWh) and Peak Load (kW)

For less detailed but still airport-specific results, enter the airport's monthly energy consumption in megawatt hours (MWh) and peak load (kW). For this, monthly copies of the airport's utility bills will be needed. Click the "Continue" button to view and download charts summarizing the airport's monthly load profile.

Option 3: Click a Sample Airport

If the airport's specific energy is unavailable, energy load profile data has been gathered from three candidate airports: A Small Hub airport, a Medium Hub airport, and a Large Hub airport. Click the sample airport energy

MODULE 1

AIRPORT PROFILE

load profile that most closely matches your airport's energy use. *Note that sample airport data is not available for Non-hub Primary, Non-primary Commercial Service, Reliever, or General Aviation airports. The Small Hub airport option would most closely match these types of airport sizes.*

Click the "Continue" button to view and download the following charts:

- Winter Weekday
- Summer Weekday
- Peak Day
- Frequency of Daily Peak Loads
- Total Consumption (MWh), and Peak Load (kW)

Electricity End Uses

Click all the Electricity End Uses associated with the terminal/building, airside, and groundside that are included in the load profile or energy consumption data. * For additional end uses that may be included in the load profile or energy consumption data, but are not listed, please click the "Other" box and input any end uses in the text box.

Summary

Module 1 has been completed. A red "X" indicates an incomplete lesson in the module. If critical information is missing, it will impact the final report. Review incomplete modules before moving forward.

A green check mark indicates a successfully completed lesson. Click the "Begin Module 2" button to continue through the AMIT.

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MODULE 2 RESILIENCE

MODULE TWO

Introduction

Optimizing resilience is often a major motivator for developing microgrids. On the *Introduction* page, then you should read through the module content details and click on the video. Click the “Continue” button to begin Module 2.

Module 2

Introduction

- Microgrid Readiness
- Backup Power Sources
- Critical Loads
- Backup And Critical Load Report
- Hazard Planning
- Hazard Planning: Microgrid Design
- Hazard Planning: Airport Emergency Plans
- Cyber Security And Airport Microgrids
- Summary

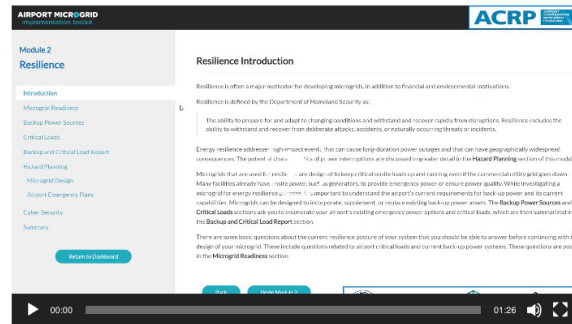
Save AMIT Progress

Introduction: Resilience

Resilience is often a major motivator for developing microgrids, in addition to financial and environmental motivations.

Resilience is defined by the Department of Homeland Security as:

The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.



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Microgrid Readiness

Before continuing with the design of the microgrid, the *Microgrid Readiness* page presents some basic questions about the current resilience readiness of the airport’s system. This inquiry includes questions related to airport critical loads and current backup power systems.**

MODULE 2

RESILIENCE

Critical Loads

Critical loads cannot be interrupted without compromising core airport function and/or life, health and safety.

1. Have you identified your critical loads?
 Yes No
2. Have you prioritized your critical loads?
 Yes No
3. Do you have data on energy usage specific to the critical loads?
 Yes No
4. Does the airport have load shedding or shifting capacities?
 Yes No

Each question contains a clickable “More Information” icon. The you can click the icon if additional information about the question is needed. *Note that the AMIT does not require you to answer “Yes” to every question listed to continue through the AMIT; however, providing responses is highly recommended prior to moving on.* Proceed to the next page by clicking the “Continue” button.

Backup Power Sources

To begin assessing the resilience to outages of the airport, details about its backup power systems are needed. Click the “Add a New Backup Power Source” button and complete the form on the following page. After entering the backup power source details, click the “Add Backup Power Source” button.*

Backup Power Sources

To help assess your airport's resilience to outages, we need to learn more about the backup power systems in place and the critical loads. Start by entering details about your airport's backup power systems.

Click the "Continue" button when you have completed adding all of your backup power sources.

Name	Type	Capacity (kW)	
<input type="text"/>	<input type="text" value="v"/>	<input type="text" value="0"/> kW	<input type="button" value="DELETE"/>

MODULE 2

RESILIENCE

All backup power sources will be listed on the *Backup Power Sources* page. Add, edit, or remove backup power sources as needed. After entering all applicable backup power sources, click the “Continue” button to move forward in the AMIT.

Critical Loads

Next, enter all loads that are critical to the operation of the project airport. Enter the critical load information in the table. The Electricity End Uses from Module 1 have been transferred over and appear as suggestions in the “Critical Load Name” input field’s autocomplete dropdown menu. Select the “Add a New Critical Load” button to add additional critical loads to the table. Critical loads with no name will be ignored.

Add, edit, or remove critical loads as necessary. All critical loads identified will be listed on the *Critical Loads* page. When all critical loads are listed, click the “Continue” button to proceed to the next lesson.

Name	Priority	Peak Demand (kW)	Backup Power Source	
<input type="text"/>	<input type="text"/>	<input type="text" value="0"/> kW	<input type="text" value="None"/>	
Total Capacity		0 kW		

Add a New Critical Load

Backup and Critical Load Report

After entering the facility’s backup power sources and critical loads, this information will be summarized within the Backup and Critical Load Report.*** The critical loads served by each backup power source is listed. If the capacity of the backup power sources is insufficient to serve the facility’s critical loads, there will be a notification indicating that additional backup power capacity may be required to meet your airport needs.

MODULE 2

RESILIENCE

Backup Power Sources

To help assess your airport's resilience to outages, we need to learn more about the backup power systems in place and the critical loads. Start by entering details about your airport's backup power systems.

Click the "Continue" button when you have completed adding all of your backup power sources.

Name	Type	Capacity (kW)	
<input type="text"/>	<input type="text" value="v"/>	<input type="text" value="0"/> kW	<input type="button" value="DELETE"/>
Total Capacity		0 kW	

[Add a New Backup Power Source](#)

Hazard Planning

Read through the energy resilience definition provided. Review the chart depicting how additional/ alternative backup sources of power can extend the project airport's ability to maintain power during an outage event. After reviewing this chart, click the "Continue" button to move forward in the AMIT.

Microgrid Design

This section includes hazard planning insight with respect to the microgrid design process. Read through the considerations related to Power Interruption Duration and considerations related to Hazard Impacts on Microgrid Equipment sections. Click the "Continue" button to proceed to the next lesson.

Airport Emergency Plans

Energy resilience considerations can be integrated into Airport Emergency Plans (AEP). Read through this section as well as the documents on Considerations and Resources for Planning and Considerations and Resources for Emergency Exercises to learn how a long-term energy outage may be addressed by the airport's AEP and emergency exercises. Click the "Continue" button to begin the next lesson.

MODULE 2

RESILIENCE

Cyber Security

On-site generation systems that are grid-connected rely on monitoring and control technology that is often connected to the public internet. Connections between airport power systems and the internet pose cyber security risks that can impact both airports and commercial grids. Read through the Cyber Security and Airport Microgrids memorandum for an overview of existing and emerging standards and literature that offers guidance for airport microgrid operators regarding cyber security.

Summary

Module 2 has been completed. A red “X” indicates an incomplete lesson in the module. If critical information is missing, it will impact the final report. Review incomplete modules before moving forward.

A green check mark indicates a successfully completed lesson. Click the “Begin Module 3” button to continue through the AMIT.

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MODULE 3

STAKEHOLDER ENGAGEMENT

MODULE THREE

Introduction

This module is intended to help identify and engage stakeholders that may be involved in the microgrid development process. On the *Introduction* page, read through the module content details and watch the video. When you are finished, click the “Continue” button to begin Module 3.

Module 3

[Module 3 – Stakeholder Engagement Introduction](#)

[Module 3 – Pre-Stakeholder Engagement Questions](#)

[Module 3 – Identifying Stakeholders](#) ▾

[Module 3 – Stakeholder Involvement By Phase](#)

[Module 3 – Engaging Stakeholders: Tenants](#)

[Module 3 – Engaging Stakeholders: Interviews](#)

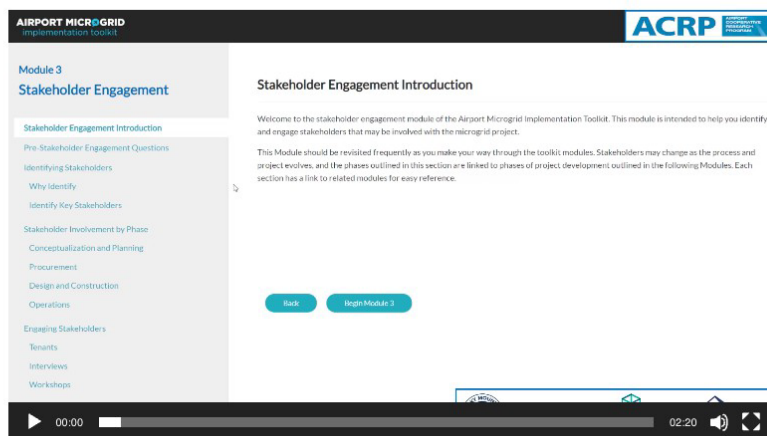
[Module 3 – Ways To Engage Stakeholders: Workshops](#)

[Module 3 – Summary](#)

 [Save AMIT Progress](#)

Introduction: Stakeholder Engagement

Welcome to the stakeholder engagement module of the Airport Microgrid Implementation Toolkit. This module is intended to help you identify and engage stakeholders that may be involved with the microgrid project.



Pre-Stakeholder Engagement Questions

Before identifying the stakeholders that will be need to be engaged throughout the microgrid development process, there are a number of factors to consider. Answer the pre-stakeholder engagement questions. If the answer is “No” to any of the questions, it is recommended that the microgrid development team gain a better understanding of the topic prior to moving forward with Module 3.

MODULE 3

STAKEHOLDER ENGAGEMENT

Identifying Stakeholders

Why Identify

Stakeholders will be an integral part of the rest of the processes required for microgrid development. Moving forward, each module will require engagement with stakeholders. Read through this page for brief descriptions about how stakeholder engagement applies to each module. In the Additional Resource section click the link to review a list of stakeholders that should be engaged and how they can contribute to the microgrid development process.

Identify Key Stakeholders

This page will introduce stakeholder mapping, an effective process to determine a list of key stakeholders to engage with during a project process. Read through this page to learn about the four steps of stakeholder mapping and the types of questions to consider when identifying stakeholders.

Stakeholder Involvement by Phase

Once stakeholders have been identified, they need to be engaged by the project champion throughout the microgrid development lifecycle. The next sections of this module – Conceptualization and Planning, Procurement, Design and Construction, and Operations – will indicate which stakeholders should be involved in each phase.

Engaging Stakeholders

Tenants

Tenants should be engaged throughout the microgrid development lifecycle. Tenants will provide input on the microgrid design, will understand their energy requirements, and may be able to help raise funding due to their unique requirements. Take a look through the linked resources to gain a better understanding of how engaging with tenants can support the development of your microgrid.

Interviews

Once stakeholders are identified, they should be engaged through formal or informal interviews to capture their understanding of the project, influence the project's success, and to voice any concerns. This section includes sample questions that can be asked while engaging with airport

MODULE 3

STAKEHOLDER ENGAGEMENT

engineering/facilities staff, airport management, utility point of contacts, federal representatives, and other airport tenants. Click on each stakeholder group to review questions specific to that sector.

Save a PDF of the questions by clicking the “Download Interviews” button located below the side menu bar.

Workshops

Workshops are another effective mechanism for gathering focused insight from multiple stakeholders at a single time. This section details the steps that should be taken to conduct a successful microgrid workshop. These steps include identifying objectives, designing an agenda, and reviewing supporting materials. Click on each step for detailed guidance.

Summary

Module 3 has been completed. A red “X” indicates an incomplete lesson in the module. If critical information is missing, it will impact the final report. Review incomplete modules before moving forward.

A green check mark indicates a successfully completed lesson. Click the “Begin Module 4” button to continue through the AMIT.

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MODULE 4

ENERGY OPTIONS

MODULE FOUR

Introduction

The purpose of this module is to evaluate different technologies to determine those most appropriate based on the airport's site-specific conditions and objectives. On the *Introduction* page, read through the module content details and click on the video. Click the "Continue" button to proceed through the module.

Module 4

Module 4 – Energy Options Introduction

Module 4 – Energy Options

Module 4 – Existing Technologies

Module 4 – Compare Technologies

Module 4 – Comparison Summary

Module 4 – Additional Technologies

Module 4 – Summary



Save AMIT Progress

Energy Options Introduction

Welcome to the energy options module of the Airport Microgrid Implementation Toolkit.

Microgrids are powered by a suite of energy generation and storage technologies. The purpose of this module is to evaluate different technologies to determine those most appropriate based on your airport's site-specific conditions and objectives.

Backup Generation Options	Key Elements	Interruption Time	Benefits and Drawbacks
Grid only (no backup)		hours	- Zero additional/capital cost - No backup during outage
Diesel Generator + Grid		~10-30s	- Low capital cost - 15 sec delay, CO2 & local emissions, noise
BESS + Grid			

Energy Options

There are a variety of electricity and heating/cooling technologies available that should be considered when developing a microgrid. Scroll through the list of technologies and read the brief descriptions associated with each technology. For additional information, click the available link associated with each technology.

Existing Technologies

The project airport may already utilize various energy technologies. Click the check-box for those technologies currently in use at the project airport. **

MODULE 4

ENERGY OPTIONS

Compare Technologies

On this page, choose technologies to compare. Click the “Select All” button if you would like to compare all technologies.* Also, choose the costs and benefits you want to evaluate: siting, levelized cost of energy, resilience, and emissions.*

Costs and Benefits to Compare

- Siting
- Levelized Cost of Energy
- Resilience
- Emissions

Comparison Summary

Based on your selections, a Comparison Chart of Technologies will be generated.*** Review the chart and identify technologies that are compelling and potentially suitable for the project airport. Note that monetizable services may be offered by the technologies selected. For a comparison of these monetizable services, please refer to Module 5: Sources of Financing. After reviewing the *Comparison Chart of Technologies*, click the “Continue” button to proceed through the module.

Comparison Chart of Technologies

Technology	Type	Time Type	Levelized Costs (\$/MWh) ¹	Resilience Services ²
Alternative Electricity Storage	Electricity			Yes
Battery Storage	Electricity	Base Load		Yes
Diesel Generator	Electricity	Base Load	\$239.00	No

MODULE 4

ENERGY OPTIONS

Additional Technologies

Click the Electricity and Heating/Cooling generation technologies being considered for the project airport's microgrid needs. ** Click the "Continue" button to proceed through the AMIT.

Summary

Module 4 has been completed. A red "X" indicates an incomplete lesson in the module. If critical information is missing, it will impact the final report. Review incomplete modules before moving forward.

A green check mark indicates a successfully completed lesson. Click the "Begin Module 5" button to continue through the AMIT.

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MODULE 5

FINANCE & OWNERSHIP

MODULE FIVE

Introduction

There are several financial motivations for implementing a microgrid. Airports should consider a range of procurement methods, ownership models, and funding sources available for microgrid development. On the *Introduction* page, read through the module content details and click on the video. Click the “Continue” button to proceed through the module.

Module 5

Module 5 – Financial Introduction

Module 5 – Outage Cost Calculator

Module 5 – Procurement

Module 5 – Ownership

Module 5 – Ownership Models

Module 5 – Financial Sources – Sources of Financing

Module 5 – Microgrid Cost-Benefit Analysis

Module 5 – Summary

Save AMIT Progress

Introduction: Financial

Welcome to the financial module of the Airport Microgrid Implementation Toolkit.

The screenshot displays the 'AIRPORT MICROGRID Implementation Toolkit' interface. The top navigation bar includes the toolkit name and the 'ACRP' logo. The main content area is titled 'Module 5 Financial' and 'Financial Introduction'. It features a sidebar menu with options like 'Introduction', 'Outage Cost Calculator', 'Procurement', 'Delivery Method', 'Ownership', 'Financial Sources', 'Airport', 'Federal and State', 'Monetizable Services', 'Cost-Benefit Analysis', and 'Summary'. The main text area contains a welcome message and introductory text about financial motivations for microgrids. At the bottom, there are 'Back' and 'Continue Module 5' buttons, and a video player interface showing a 02:12 duration.

Outage Cost Calculator

To better formalize the benefits of microgrids, it can be helpful to analyze the cost of an electricity outage. The Outage Cost Calculator computes the estimated cost for an outage of a specific duration based on your airport’s annual volume and includes losses for: domestic and international ticket sales, aircraft belly freight, dedicated cargo, transport revenue, and concession revenue.

MODULE 5

FINANCE & OWNERSHIP

To calculate the project airport’s potential annual financial losses due to power outages, enter the following:

- annual number of passenger enplanements
- the percentage of flights at your airport that are domestic
- the percentage of flights at your airport that are international
- the average outage duration at your airport
- the number of outages per year

If these figures are not readily available, refer to the utility provider’s SAIDI/SAIFI results detailed in Module 1: Reliability Information.* If the project airport has dedicated cargo services, click the airport from the dropdown list of dedicated cargo airports to populate annual dedicated cargo tonnage. If the project airport is not on the list included, click “Enter Custom Annual Cargo Tonnage” and enter the appropriate amount in the text box.* Click the “Compute Outage Costs” button.***

For details regarding the assumptions of the Outage Cost Calculator, click the “Cost Calculator Assumptions” button. Click the “Continue” button to continue through the module.

Data Field	Value
Annual number of passengers	<input type="text"/>
Domestic flights	<input type="text" value="77"/> %
International flights	<input type="text" value="23"/> %
Average outage duration	<input type="text"/> hour(s)
Outages per year	<input type="text"/>
Airport	-- Enter Custom Annual Cargo Tonnage -- <input type="button" value="v"/>
Annual cargo tonnage	<input type="text"/>
Annual cargo revenue	\$0.00
Total Losses	<i>Enter values into all of the calculator textboxes and then click the Compute Outage Costs button to see an estimate for the annual cost for electricity outages.</i>

 Cost Calculator Assumptions

 Compute Outage Costs

MODULE 5

FINANCE & OWNERSHIP

Procurement

Clicking the appropriate procurement method for the project airport is an important step in the microgrid development process. On this page, read through the procurement steps. A number of airport microgrid procurement documents including RFPs, RFIs, RFQs, as well as feasibility assessments have been included as a reference. After reviewing these materials, click the “Continue” button to proceed through the module.

Delivery Method

There are various procurement methods that can be taken to deliver a project. On this page explore the following delivery methods: Design Bid Build (DBB), Design Build (DB), Construction Manager- at-Risk (CMAR), Integrated Project Delivery (IDP), and Performance Contracting. Click each method to read its description.

Delivery Method Wizard

To make it easier for the project airport’s procurement team, the Master Module includes a way to rank the project delivery choices based on priority. Drag and drop each project delivery choice as needed to get them in the desired order. Click the “Next” button below.

Place the five project delivery choices in order of importance based on the team priorities. The item at the top should be the most important, the second item from the top the second most important, and so on. Drag and drop each project delivery choice as needed to place them in the desired order.

Secure lowest "first cost"

Limit the number of procurement actions

Delegating project management decisions to trusted 3rd party

Maximize collaborative ideas between airport, designer and builder"

Minimize the need for capital investment funding

NEXT



MODULE 5

FINANCE & OWNERSHIP

Generate expedited internal approval via familiar procurement

Accelerate project schedule

Obtain high level of cost control from start

Pursue airport innovation at leading edge despite potential risks

Focus exclusively on project performance outcomes

PREVIOUS NEXT

● ● ●

Click the “Previous” button to return to the previous selection and review your order. Once both priority lists are finalized, click the “Continue” button to proceed through the module.

Ownership

There are several different ownership models that can be used in the development of microgrids. Microgrid system ownership determines who will operate and maintain the system and who owns any value and revenue streams it generates. Review the *Ownership Introduction* page. Click the “Continue” button to proceed through the module.

On the next page, review the three ownership model options: third-party ownership, airport ownership, and hybrid airport and third party-ownership. Click the “Additional Resource” link for a more detailed analysis of microgrid ownership and service models. Click the “Continue” button to proceed through the module.

Financial Sources

The various ownership structures provide pathways to funding and financing based on the respective owners’ authorities, expertise, and access to capital. Eligible microgrid projects can also apply for grant funding or financing from federal or state energy finance initiatives. A description of various sources of financing is provided on the following pages. Click the “Continue” button to review airport, federal and state, and monetizable services available for microgrid funding.

MODULE 5

FINANCE & OWNERSHIP

Cost-Benefit Analysis

Conducting a cost-benefit analysis is an important step for an airport considering implementing a microgrid. One way to begin the process is by using an existing microgrid cost-benefit model developed by NYSERDA and Industrial Economics, Inc. Click the “user guide” link to access the model user guide and spreadsheet free of charge from NYSERDA. *Note that the use of this tool is for preliminary analysis purposes and that a comprehensive cost-benefit analysis should be included in a feasibility study conducted by third party consultants or internal experts.*

Summary

Module 5 has been completed. A red “X” indicates an incomplete lesson in the module. If critical information is missing, it will impact the final report. Review incomplete modules before moving forward.

A green check mark indicates a successfully completed lesson. Click the “Begin Module 6” button to continue through the AMIT.

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MODULE 6

OPERATIONS & MAINTENANCE

MODULE SIX

Introduction

This module outlines microgrid operations and maintenance (O&M) considerations and how they integrate into existing airport O&M strategies. Read through the module content details and click on the video. Click the “Continue” button to proceed through the module.

Module 6

Module 6 – Operations and Maintenance Introduction

Module 6 – Overview: O&M at Airports

Module 6 – Microgrid O&M Requirements and Costs

Module 6 – O&M Contracting Strategies

Module 6 – O&M Stakeholders

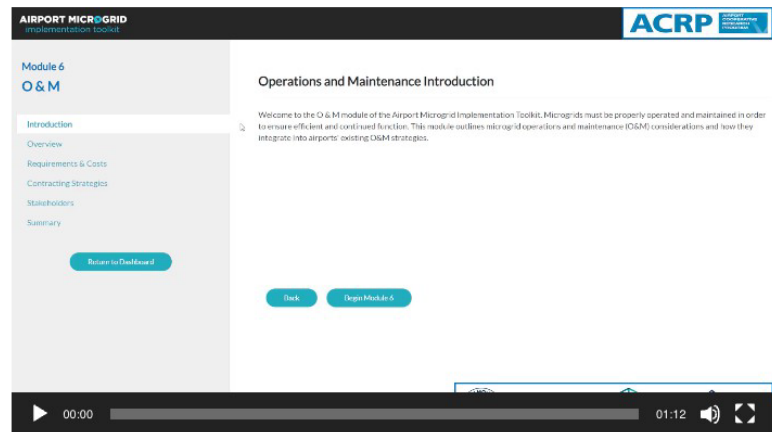
Module 6 – Summary



Save AMIT Progress

Introduction: Operations and Maintenance

Welcome to the O & M module of the Airport Microgrid Implementation Toolkit. Microgrids must be properly operated and maintained in order to ensure efficient and continued function. This module outlines microgrid operations and maintenance (O&M) considerations and how they integrate into airports' existing O&M strategies.



Overview

Airport operations and maintenance is complex and dynamic, with a focus on the facilities, utilities, infrastructure, and equipment to support the movement of people and material in both secure and public spaces. To navigate through the complexity of O&M, this section references two ACRP reports: **ACRP Web-Only Document 37: Research Roadmap in the Area of Airport Operations and Maintenance** and **ACRP Report 110: Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance**. Read through this section and refer to the linked sources for additional O&M guidance.

MODULE 6

OPERATIONS & MAINTENANCE

Requirements and Costs

The O&M requirements may vary widely depending on the technologies included, the microgrid size, and the geographic scope covered by the microgrid. This section identifies the typical costs associated with microgrid O&M. Read through the guidance included on this page. Click the “Continue” button to proceed to the next lesson.

Contracting Strategies

Airports can take different approaches to operating and maintaining microgrids, depending on factors such as airport staff capabilities, O&M budgets, and airport appetite for operational risk. Broadly, these models can include third-party ownership and operation, O&M contracts, and in-house O&M. Read through the details of each of these contracting strategies. Click the “Continue” button to proceed to the next lesson.

Stakeholders

The stakeholder engagement process, as covered in Module 3, includes stakeholders that should be involved to help identify O&M costs, limitations, and requirements. Recommended stakeholders to engage with regards to O&M include: utility provider(s), tenants, state public utility commission (PUC), airport staff and current O&M providers. Refer to Module 3 for further guidance related to O&M stakeholder engagement. Click the “Continue” button to proceed to the next lesson.

Summary

Module 6 has been completed. A red “X” indicates an incomplete lesson in the module. If critical information is missing, it will impact the final report. Review incomplete modules before moving forward.

A green check mark indicates a successfully completed lesson. Click the “Begin Module 7” button to continue through the AMIT.

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MODULE 7

MASTER MODULE

MODULE SEVEN

Introduction

This module provides a summary of the key AMIT outputs for a microgrid at the project airport. Read through the module content details and click on the video. Click the “Continue” button to proceed through the final module.

Module 7

Module 7 – Master Module Introduction

Module 7 – Microgrid Design Process Review

Module 7 – Downloadable Resources

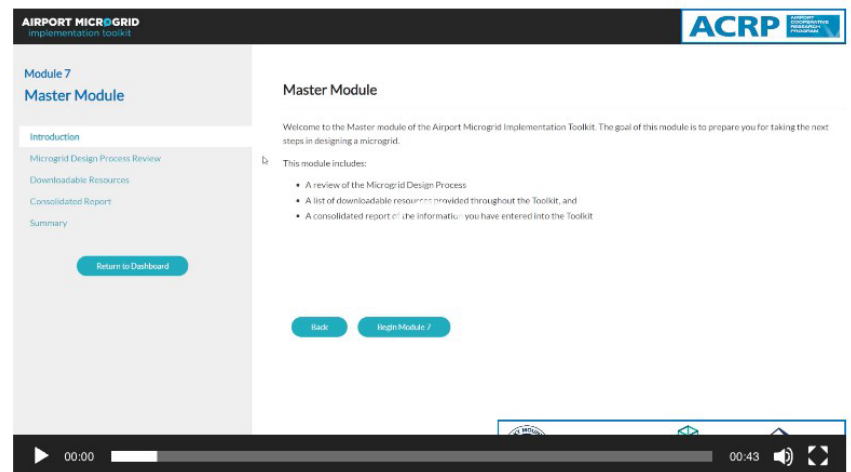
Module 7 – Consolidated Report

Module 7 – Summary

 Save AMIT Progress

Introduction: Master Module

Welcome to the Master module of the Airport Microgrid Implementation Toolkit. The goal of this module is to prepare you for taking the next steps in designing a microgrid.



Microgrid Design Process

As first seen in Module 0, the “Elements for Microgrid Realization” diagram is included again here for review and to help track progress relative to the complete microgrid implementation process. Click the “Continue” button to proceed through the module.

Downloadable Resources

Review the downloadable documents available in the AMIT. Click the “Continue” button to proceed through the module.

MODULE 7

MASTER MODULE

Consolidated Report

This report consolidates the data that has been entered into the AMIT for the project airport. Use this report to take informed next steps developing an airport microgrid. Click the “Download Report” button to save a PDF copy, then click “continue” to complete the AMIT. ***

Consolidated Report

This module provides a master microgrid overview for your airport. The module displays progress and outstanding areas that can still be completed.

Module 1: Airport Characteristics

- Your airport is **2H5**.
- Compared to national averages, your utility provider has reported **NaN%** better reliability for frequency of outages and **NaN%** better reliability for duration of events. Extended duration risks from extreme weather and threats such as cyber attack are increasing and are not reflected in historical data.
- Microgrids provide a range of benefits besides backup power and decisions to adopt a microgrid can include long term savings on utility costs and meeting clean energy generation goals.
- Your annual airport energy usage is **5,739 MWh** with a peak load of **1,025 kW**.

Summary

Congratulations on completing the Airport Microgrid Implementation Tools (AMIT).

The AMIT is designed as a dynamic support source that can be useful throughout the microgrid development process. The AMIT can be completed multiple times, so return as needed.

Feedback

If you have specific suggestions for improving or adding new AMIT functionality, please use the “Feedback” form that can be accessed on the top menu of the AMIT website.

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MODULE 7

MASTER MODULE

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AIRPORT MICROGRID IMPLEMENTATION TOOLS

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