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Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance

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ACRP REPORT 110

Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance

User's Guide and Research Report

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T R A N S P O R T A T I O N   R E S E A R C H   B O A R D

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

NOTICE

The project that is the subject of this report was a part of the Airport Cooperative Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

The Transportation Research Board of the National Academies, the National Research Council, and the sponsors of the Airport Cooperative Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.

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COOPERATIVE RESEARCH PROGRAMS

FOREWORD

By Marci A. Greenberger
Staff Officer
Transportation Research Board

ACRP Report 110: Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance provides an evaluation process and cost–benefit tool to evaluate lifecycle costs of sustainability practices being considered by airport operators. The User's Guide discusses the evaluation process (EP) and how to navigate the cost–benefit tool (CBT) and provides information from the case studies that were conducted in the development of the EP&CBT. The evaluation process and cost–benefit analysis tool is designed to evaluate sustainability practices in water conservation, energy conservation, waste management, consumables and materials, and alternative fuels. However, the tool can be used to evaluate any two practices, sustainable or otherwise. An instructional video that demonstrates how to use the evaluation process and cost–benefit tool using data from an example project (also provided with the tool) can be found at the TRB website (http://www.trb.org/main/blurbs/170580.aspx).

Many airports are implementing practices that are considered to be sustainable, i.e., they have environmental, social, and/or economic benefits. Airports implement sustainable practices because of local and regional priorities, or because the implementation costs may have appeared to be relatively inexpensive without long-term implications being considered. A lifecycle analysis looks at not only the capital costs and retiring costs but also the ongoing maintenance costs.

Booz Allen Hamilton, as part of ACRP Project 09-06, developed an evaluation process and a cost–benefit analysis tool to evaluate such practices, techniques, methods, or equipment. The User's Guide provides a step-by-step review of the tool and includes an information sheet identifying the relevant data needed to evaluate the practices. The User's Guide and the EP&CBT will be useful to airport environmental, operations, maintenance, and executive staff in evaluating the costs and benefits between existing and proposed practices.

C O N T E N T S

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance

Many airports are implementing sustainability practices. Airport maintenance departments are asked to support and maintain new systems, practices, or pieces of equipment as a result of integrating these sustainability practices, but they often do not have an opportunity to evaluate or raise concerns associated with this support or maintenance prior to implementation. It is prudent for airports to (1) assess the full lifecycle budgetary and operational implications of various sustainability practices, as some may require more maintenance and upkeep than originally anticipated, and (2) engage operations and maintenance (O&M) departments early in the process so that proper planning can take place. The purpose of this project was to develop an evaluation process and cost–benefit tool (EP&CBT) to help airports consider the O&M impacts of implementing sustainability practices.

The cornerstone of this project involved a case study to obtain data about current practices and potential improvements to the way airports evaluate the O&M impacts of implementing sustainability practices. These data provided the foundation required to develop the EP&CBT for airports to analyze potential O&M impacts from implementing new sustainability practices. The project team used a three-phased approach to execute the case study and develop the EP&CBT. The approach consisted of interviewing airport personnel to validate tool requirements and collect data; developing the EP&CBT proof-of-concept based on information and recommendations garnered from the interviews; and testing the proof-of-concept with airport staff and refining the EP&CBT. The resulting tool is easy to use and allows the user to enter quantitative and qualitative information to display key metrics in numerical and graphical form. The accompanying user guide serves as a step-by-step tutorial for using the tool. There is potential for enhancement of the evaluation process/tool and adaptation as new sustainability practices emerge.

Part I discusses the EP&CBT. Chapter 1 explains its purpose and audience. Chapter 2 is the tool's user guide. It provides background information on the tool, its structure and requirements, guidance on how to use the tool and its outputs, and troubleshooting help. Part II discusses the tool development effort. Chapter 3 describes the research conducted prior to the case studies. Chapter 4 presents the case study approach and the results of each of its phases.

1

PART I

Evaluation Process and Cost–Benefit Tool

Introduction

1.1 Statement of the Problem

There are many airports that have been implementing sustainability practices (i.e., those practices having environmental, social, economic, or operational efficiency benefits). Airports may implement sustainability practices because of local and regional priorities, the availability of grant funds for that particular project or practice, and/or the practice may have appeared to be relatively inexpensive to implement. Airport maintenance departments are asked to support and maintain new systems, practices, or pieces of equipment as a result of integrating these sustainability practices, but often do not have an opportunity to evaluate or raise concerns associated with this support or maintenance prior to implementation. It is prudent for airports to assess the full lifecycle budgetary and operational implications of various sustainability practices, as some may require more maintenance and upkeep than originally anticipated. There have been many studies and materials written on sustainability for airports, but very little has been done to look at operations and maintenance (O&M) implications of these practices, either during project startup or as they mature.

1.2 Research Objective

Commissioned by the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP), this project's purpose was the development of an evaluation process and cost–benefit tool (EP&CBT) to evaluate the day-to-day O&M impacts of implementing sustainability practices at airports. The evaluation process had to be applicable to these categories of sustainability practices:

- Water conservation
- Energy conservation
- Waste management
- Consumables and materials (e.g., paper products, paints, light bulbs, filters)
- Alternative fuels

For the purpose of this project, day-to-day airport O&M was defined as those functions and activities performed by facility O&M staff that routinely keep the facilities operating and in good condition, such as maintaining buildings, grounds, utilities, pavement, and equipment; operating public spaces such as terminal roadways/curbs, passenger terminal lobbies, and bag claim areas; and operating non-public secured areas such as baggage handling areas, aircraft aprons, taxiways, runways, and landscapes included within airport perimeter fencing. Day-to-day airport O&M does not include three other broad categories of management activities: (1) the longer-term airport management functions such as planning, finance, accounting, information

technology, lease negotiations, engineering and construction management, public affairs and communication, and marketing; (2) emergency management functions such as fire, police, security, and public health and safety; and (3) the operations of tenants such as airlines, terminal and ground access concessionaires, and agencies such as the Federal Aviation Administration (FAA) and the Transportation Security Administration (TSA).

1.3 Audience

The targeted audience of the EP&CBT is airport facility O&M staff, airport decision makers who select sustainability initiatives for implementation, and airport groups that establish sustainability policy. Use of this tool by the targeted audience will help airports with their sustainability efforts by ensuring that O&M considerations are factored into the decision-making process. Some airports have already adopted a fully developed O&M cost–benefit procedure and tool suite to analyze the implementation of new practices; EP&CBT will primarily benefit those airports—often the small to medium-sized airports—without a cost–benefit tool. This tool can act as a supplement or additional instrument to aid in the decision-making process for airports of all sizes. Every effort was made to make the tool as user-friendly as possible. The project team chose to develop the tool in Microsoft® (MS) Excel, as this program is ubiquitous and already used in various capacities at many airports. Users, therefore, will likely not have to purchase any additional software. Additionally, many users will already be familiar with using MS Excel. Data can also easily be copied from the tool to another MS Excel document or to another program, enabling easy use of the tool outputs in other analyses.

EP&CBT User Guide

This chapter contains the EP&CBT User Guide. The User Guide was developed to provide the user with all the information necessary to use the tool.

2.1 Overview of the Evaluation Process and Cost–Benefit Tool

2.1.1 Purpose of the Evaluation Process and Cost–Benefit Tool

The purpose of the EP&CBT is to evaluate the future and planned day-to-day O&M impacts resulting from implementing sustainability practices at airports. For the purpose of this tool, day-to-day airport O&M is defined as those functions and activities performed by facility O&M staff that routinely keep the facilities operating and in good condition. These may include efficient equipment operations, illumination activities, and air ventilation management, to name a few.

2.1.2 System Design

The EP&CBT is a spreadsheet-based tool that integrates a multiple-worksheet input interface, integrated function-based computation engines, and a database. The EP&CBT was developed as a self-contained MS Excel macro-enabled workbook compatible with MS Excel 2007 and MS Excel 2010 (graphics in the Performance & Qualitative Impact section will appear differently in MS Excel 2007). The tool is not compatible with MS Excel 2013. The single-file, self-contained design was chosen to keep the tool simple and easy to use. There are no additional location requirements for installing the tool or storing data.

2.1.3 Tool Architecture

The tool interface consists of a linear progression of worksheets that provide information and obtain input from the user, and calculate and display output results based on that input. The workbook contains several background data and computation worksheets that have been hidden from the user to protect the data and formulas they contain. All worksheets have been organized to provide a logical and easy-to-use organization of the information. The tabs have been color coded to coordinate with the steps in the Evaluation Process.

2.2 Components of the Evaluation Process and Cost–Benefit Tool

The EP&CBT combines an evaluation process (EP) and a cost–benefit tool (CBT) and comprises Inputs and Outputs sections. The EP component guides users to scope the analysis and collect relevant data that will be used in the CBT. Cost categories serve as "memory

Figure 1.   Overview of the EP&CBT.

joggers" to help users realize additional unanticipated impacts that they may not have thought of otherwise. The CBT component further helps the user sort the data into cost categories and qualitative categories to support the quantitative and qualitative assessment of potential impacts resulting from the implementation of sustainability initiatives on maintenance budgets and resources.

The following sections provide user instructions on how to input data within the tool; an overview of the tool is provided in Figure 1. Results and outcomes are detailed in Section 2.8.

2.2.1 Inputs Section

In the Inputs section, the user enters various types of information that will be used to determine the net O&M impact of implementing the sustainability practice at the airport. This includes qualitative and quantitative information both about the sustainability practice to be implemented and about the current state of affairs at the airport, such as if there are current practices in place that will be replaced by the new sustainability practice. The project team leveraged data gathered from the interviews at the case study airports in determining both the types of data that are collected in this section and the structure through which they are collected.

2.2.2 Outputs Section

In the Outputs section, the information collected in the Inputs section is displayed in such a way as to provide a comprehensive and adaptable view to the user. Key metrics specifying the monetary impacts of the sustainability practice are presented, both in numerical and graphical form. The user is able to view cost impacts both at an aggregate and individual cost level. The qualitative impacts identified in the Inputs section are represented in a manner that highlights the most significant impacts to the airport. The project team leveraged data gathered from the airport interviews in determining the format in which cost data are organized and which key output metrics are included.

2.3 EP&CBT Users

The tool is designed for use by airport facility O&M staff and airport groups that establish sustainability policy. The time it takes to use the tool may vary, depending on the complexity of the sustainability practice and the level of data the user has on hand. It can be completed in less than an hour but can take longer depending on the complexity of the project and the amount of data that the user still needs to collect. At any time, the user can save an analysis and return later to update or modify inputs.

2.4 General Tool Functions

2.4.1 Navigating the Tool

The tool provides navigation arrow buttons on each screen to help the user move forward and backward within the tool. The tool also provides a button enabling the user to return to the EP Overview screen at any time. These navigation buttons are placed at the top right of each worksheet within the tool.

The tool also provides a progress bar within the input sections to show user progress through these sections. The user can click on the different sections of this progress bar to navigate to those sections of the tool. The progress bar is placed at the top right of the worksheets in these sections.

2.4.2 Help Screens

The tool provides help screens for all lifecycle cost sections as well as the cost entry window, and for the Performance & Qualitative Impacts input section, to help guide the user through the process of evaluating the sustainability practice. Help buttons can be found at the top right of the worksheets or input forms and will launch a help window specific to the current page the user is on in the tool. Additionally, all input sheets provide extensive information on how to complete the section and the Output – Charts section contains a help screen to help the user navigate the presented outputs.

2.4.3 Saving

The EP&CBT restricts the manner in which the user can save the file in order to maintain an unaltered version of the tool to be used for evaluation of future sustainability practices. Attempting to *Save* the original EP&CBT from within the tool will bring up the message box shown in Figure 2, instructing the user to *Save As* a new file, and preventing the user from saving over the original workbook.

Attempting to *Save As* from the original EP&CBT will bring up the message box shown in Figure 3. It prompts the user to save the file as either one of these two options:

1. EPCBT 'Name of Practice' 'Current Date': The user applies this option to save data entered in evaluating the sustainability practice. The user continues to *Save* this version or *Save As* with the current date, as s/he continues to evaluate this practice.
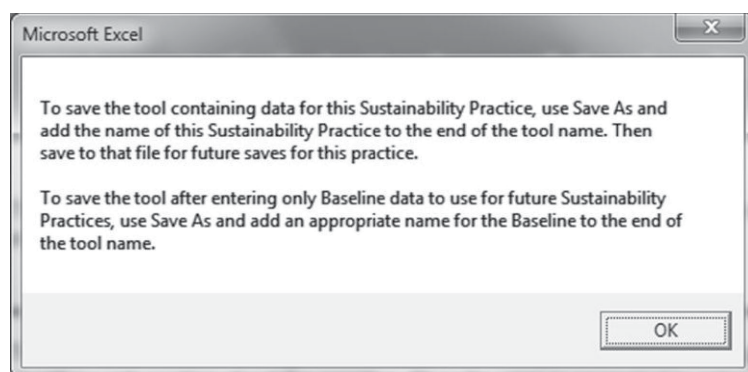
Figure 2.   Saving in Excel.
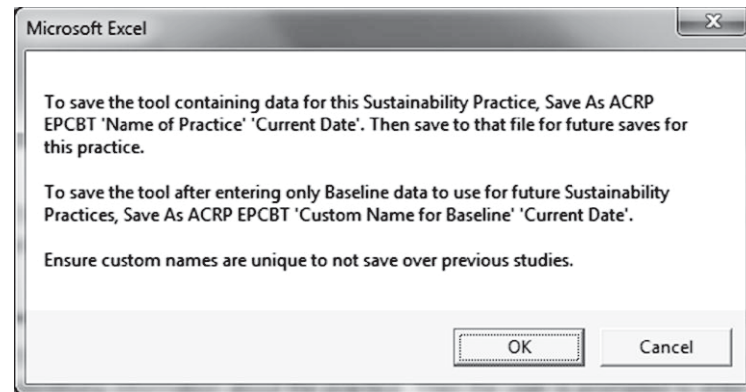
Figure 3.   **Save As** *in Excel.*

2. EPCBT 'Name of Baseline' 'Current Date': The user applies this option if s/he has entered only baseline data and wishes to use this baseline in the evaluation of other sustainability practices. When beginning to evaluate other practices, the user should use this file to avoid reentering the baseline data. Not all practices should use the same baseline data, as not all practices will replace the same current practice.

2.5 Information Sheet

Certain information is required to complete the EP&CBT, including information about costs, schedules, and the relevant period of analysis. Most data can be obtained prior to using the EP&CBT; however, as the tool is designed to help the user think of relevant costs and impacts that might not have been previously considered, the user may need to retrieve additional information after beginning to use the EP&CBT. Table 1 provides a list of the types of data the user will need in order to complete the EP&CBT for a sustainability practice.

Table 1.   Data used in the EP&CBT.

Data	Description
Sustainability Practice & Airport Information	Information about the new practice, the airport, and the analysis to be conducted
Name of Sustainability Practice	Unique name for the sustainability practice
Airport Name	Airport name where practice is being implemented
Description of Sustainability Practice	Detailed description of practice
Period of Analysis	Time period to consider when evaluating the sustainability practice. The relevant time period may be different for different practices.
Discount Rate	Discount rate takes into account the time value of money and uncertainty of anticipated future cash flows. Net Present Value (NPV) uses the discount rate to provide a present value of cash flows that extend into the future. The tool provides a default discount rate of 7%, the standard value used for all airport projects to be funded with federal grant funds, but the user may use a custom discount rate for analysis.
Sustainability Practice Type	- Water Conservation - Energy Conservation - Waste Management - Consumables & Materials - Alternative Fuels
Airport Functional Areas that will be Impacted	- Terminal Buildings/Concourses - Navigational Aids (NAVAIDS), Lighting, and Electrical Vaults - Facilities - Heating, Ventilation, and Air Conditioning (HVAC) and Other Utilities - Stormwater Management Facilities - Water/Waste Water Treatment - Vehicle Maintenance and Fueling Facilities
Current Practice (Baseline) Costs	Relevant if the new sustainability practice is replacing a current practice. Includes all costs that are incurred using the current practice, but will no longer be incurred once the new sustainability practice is implemented.
Name of Cost	Unique name for the cost item
Cost Sub-Category	- Personnel - Materials & Supplies - Contractual Services - Operations - Capital Outlay - Interdepartmental - Other Expenditures
Description of Cost and Impacts	Description of what is included in the cost item
1) **Total Costs by Year**	Total rolled up costs for the item in each year
OR	
2) **Range of Years during which Cost is Incurred**	Range of years during which the cost is incurred, from first year to last year
2) **Frequency with which Cost is Incurred**	Frequency with which cost is incurred, one time only or a set schedule
2) **Unit Type of Cost**	Type of cost incurred, e.g., hours if entering labor, light bulbs if entering materials, contracts if entering contractual services
2) **Unit Quantity of Cost**	Number of units included in cost, e.g., number of hours spent
2) **Unit Price of Cost**	Cost per unit, e.g., wages

(continued on next page)

Table 1. (Continued).

Data	Description
New Sustainability Practice Costs	Includes all lifecycle costs that are incurred due to the sustainability practice
Name of Cost	Unique name for the cost item
Cost Subcategory	- Personnel - Materials & Supplies - Contractual Services - Operations - Capital Outlay - Interdepartmental - Other Expenditures
Description of Cost and Impacts	Description of what is included in the cost item
1) **Total Costs by Year**	Total rolled up costs for the item in each year
OR	
2) **Range of Years during which Cost is Incurred**	Range of years during which the cost is incurred, from first year to last year
2) **Frequency with which Cost is Incurred**	Frequency with which cost is incurred, one time only or a set schedule
2) **Unit Type of Cost**	Type of cost incurred, e.g., hours if entering labor, light bulbs if entering materials, contracts if entering contractual services
2) **Unit Quantity of Cost**	Number of units included in cost, e.g., number of hours spent
2) **Unit Price of Cost**	Cost per unit, e.g., wages
Performance & Qualitative Impacts	Includes performance and qualitative impacts resulting from the implementation, use, and disposal of the new sustainability practice, including all relevant impacts that were not captured in the costs
Impacts to Standard Impact Categories	- Institutional Tenant Experience - Traveler Experience - Local Community Experience - Public Support - Occupational Health & Safety - Operational Continuity/Emergency Preparation - Supports Airport Strategic Plan
Additional Impacts	Impacts to relevant additional performance and qualitative areas, e.g., airport-specific core values

2.6 How to Start a New Analysis

The first tab of the EP&CBT contains a brief introduction that describes the purpose of the tool, the tool structure, and explanation of outputs, as shown in Figure 4. The user can navigate to the overview of the evaluation process by selecting *Next*, circled in Figure 4.

The second tab contains an overview of the evaluation process, shown in Figure 5. It also contains simplified directions and a summary of the tool methodology. Scroll down in the tab to view directions, shown in Figure 6.
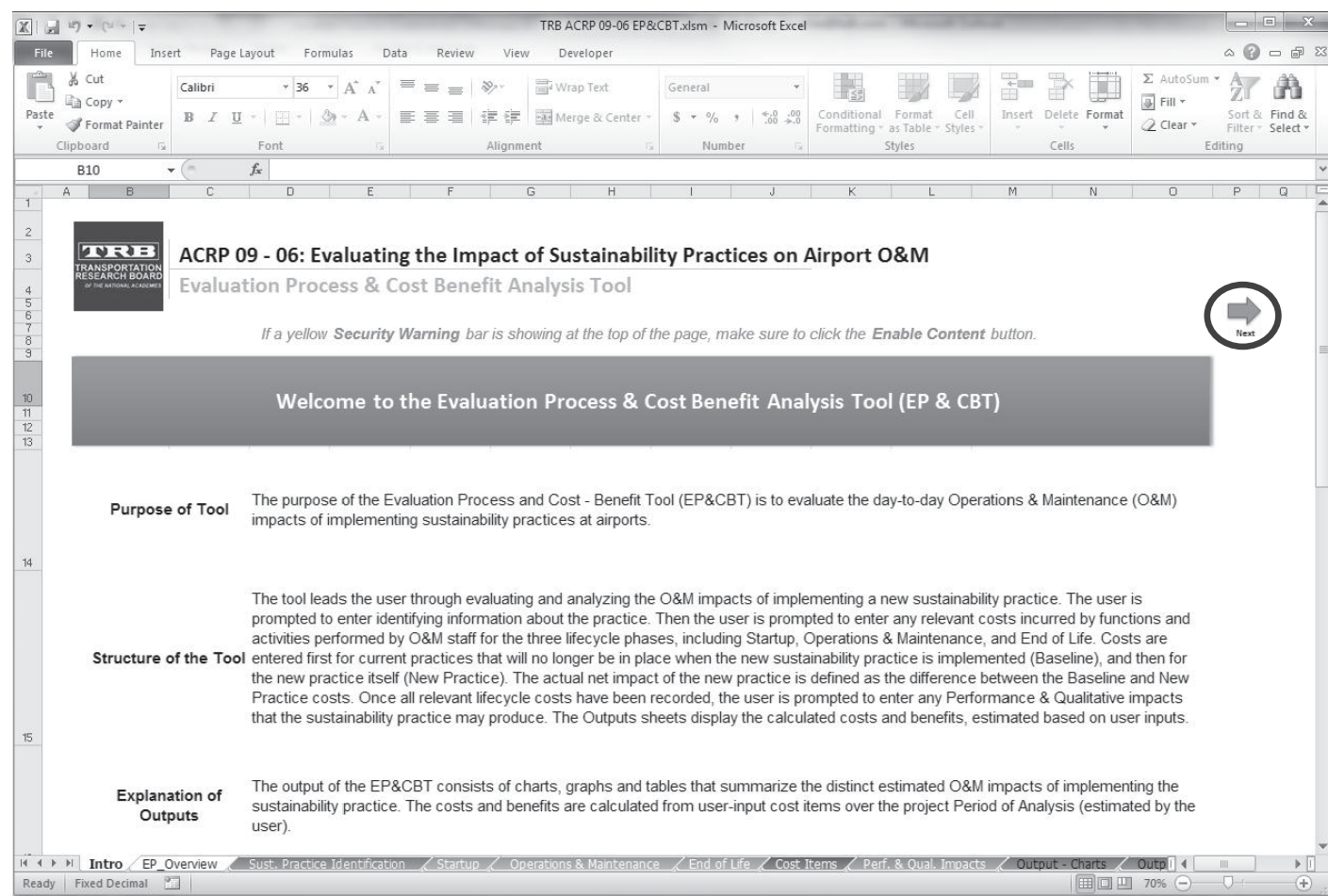
Figure 4.   Introduction to the tool.
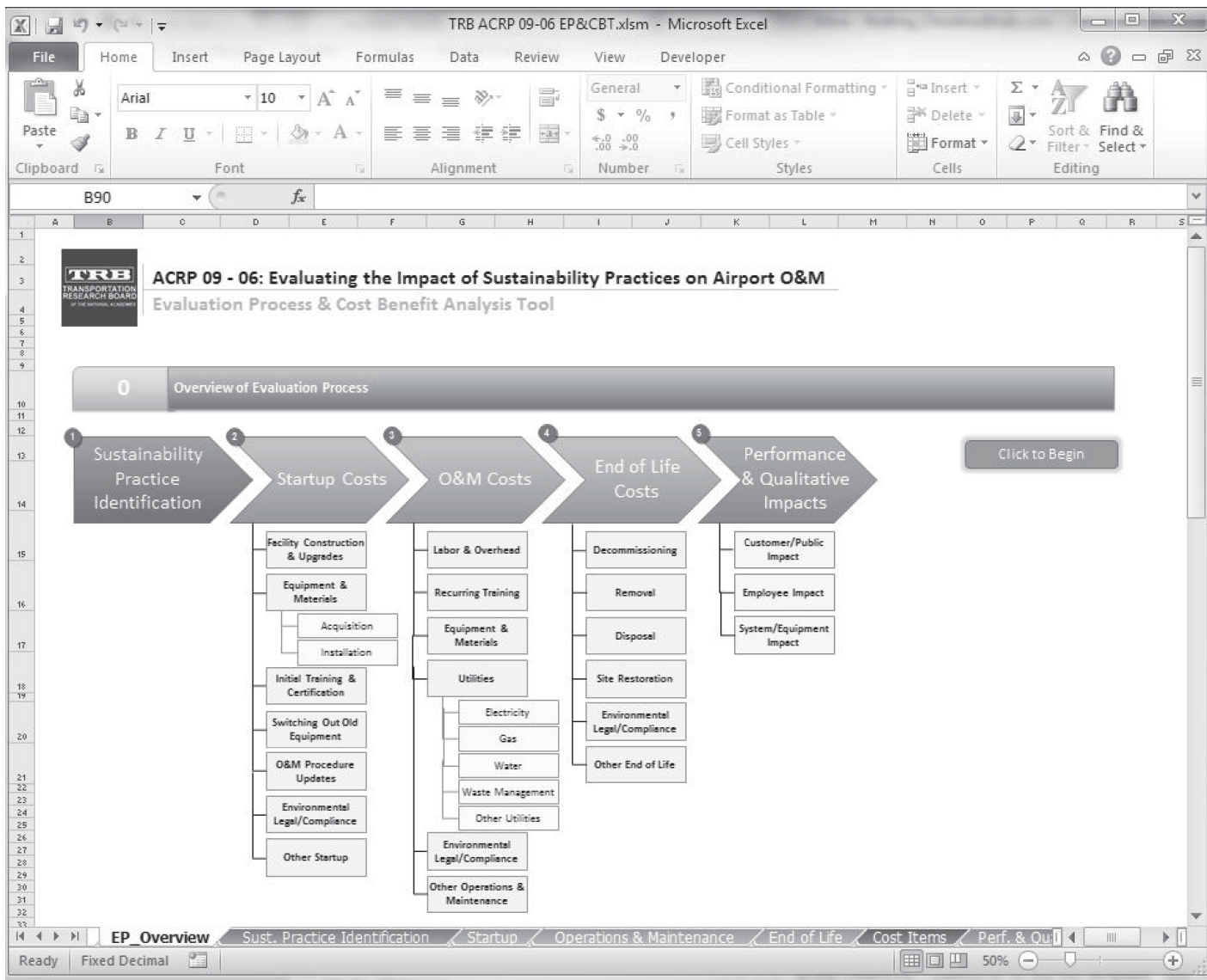
Figure 5.   Overview of the evaluation process.

Figure 6.   *Overview of the evaluation process—Directions of Use.*

2.7 Inputs

The Inputs section leads the user through the collection and recording of all data relevant to the evaluation and cost–benefit analysis of the baseline scenario or sustainability practice being considered. It comprises five steps in three subsections: *Sustainability Practice Identification;* lifecycle costs for *Startup Costs*, *O&M Costs*, and *End of Life Costs* (the *Cost Items* output provides a summary of the costs entered); and *Performance & Qualitative Impacts.*
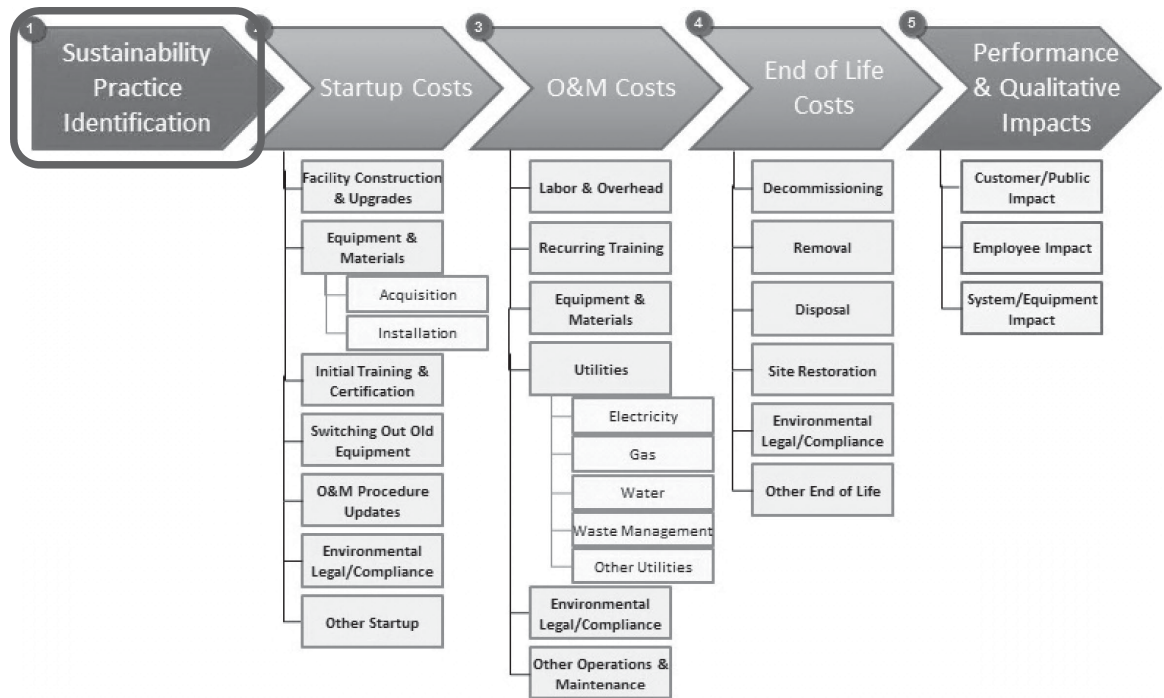
Figure 7.   Step 1 of the evaluation process.

2.7.1 Sustainability Practice Identification

The first step, shown in Figure 7, is to identify the sustainability practice the airport is interested in implementing.

Figure 8.   **Click to Begin** *button.*

1. From the *EP_Overview* tab, select the red *Click to Begin* button on the right side of the Overview of Evaluation Process flowchart, shown in Figure 8, which takes the user to the *Sust. Practice Identification* tab.
2. Enter information in the table, shown in Figure 9, specific to the sustainability practice to be implemented. This information can be changed or updated at any time during the analysis.

Input Category	Description	Input	
Sustainability Practice ID	Enter a unique name for the sustainability practice	Test 1	✓
Airport Name	Enter the name of the airport considering using this sustainability practice	Test Airport	✓
Date Created	Enter the current date	11/13/2013	✓
Detailed Description of Sustainability Practice to be implemented	Enter a detailed description of the sustainability practice being evaluated	Detailed Description of Test 1	✓
Period of Analysis (years)	Enter the time period of analysis for this sustainability practice between 1 and 40 years - only costs within this time period will be considered. The time period may depend on the scope of analysis being conducted by the airport or on the length of the lifecycle of the sustainability practice	30	✓
Discount Rate for NPV Analysis	Enter the discount rate to be used for the Net Present Value (NPV) calculation – discount rate takes into account the time value of money and uncertainly of anticipated future cash flows. NPV uses the discount rate to provide a present value of cash flows that extend into the future. The tool provides a default discount rate of 7%, the standard value used for all airport projects to be funded with Federal grant funds, but the user may enter a custom discount rate for analysis	7%	✓

Figure 9.   Identification of sustainability practice to be implemented.

The red "X" on the right side of this table will become a green check mark once the associated sections are filled in. A reminder will appear if the user has not entered all necessary input (see Figure 10).

The input categories and descriptions are as follows:

a. *Sustainability Practice ID:* Enter a unique name for the sustainability practice.
b. *Airport Name:* Enter the name of the airport at which the sustainability practice is being implemented.
c. *Date Created:* Enter the current date.
d. *Detailed Description of Sustainability Practice to be Implemented:* Enter a detailed description of the sustainability practice that is being implemented.
e. *Period of Analysis (years):* Enter the time period of analysis for this sustainability practice; only costs within this time period will be considered. The user should consider the full life-cycle of the sustainability practice and the scope of the airport's assessment when choosing a period of analysis. The selection should reflect the time period the airport wishes to consider when evaluating the sustainability practice. The relevant time period may be different for different practices.
f. *Discount Rate for NPV Analysis:* Enter the discount rate that the tool will use for the net present value (NPV) calculation; discount rate takes into account the time value of money and uncertainty of anticipated future cash flows. NPV uses the discount rate to provide a present value of cash flows that extend into the future. The tool provides a default discount rate of 7%, the standard value used for all airport projects to be funded with federal grant funds, but the user may enter a custom discount rate for analysis.

3. Select a sustainability practice type from the table as shown in Figure 11. Select only one practice type per analysis.
4. Select airport functional areas to be impacted from the table as shown in Figure 12. Multiple functional areas cans be selected at once. Click on the functional area to select or deselect it.
5. Select the blue Next arrow (Figure 13) on the right side of the spreadsheet to move to the life-cycle costs subsection. A box (Figure 14) will open up, which provides the user with general cost inputs guidance and suggestions to assist during the cost inputs phases. Click the gray button at the bottom of the box to continue.

Figure 10.   Reminder—input needed.

Figure 11.   Select sustainability practice type.

Figure 12. Select airport functional area to be impacted.

Figure 13. Previous/Next buttons.

Another box, shown in Figure 15, will open, prompting the user to enter all relevant baseline costs. Baseline costs include all costs that are incurred using the current practice but will no longer be incurred once the new sustainability practice is implemented; these costs are discussed further in Section 2.7.2. Click *OK* to proceed to the *Startup Costs* input tab.

2.7.2 Lifecycle Costs

This section includes the EP and cost entry interface for all O&M costs falling within the lifecycle of the sustainability practice, allowing the user to input costs due to the sustainability practice as well as baseline costs that will no longer be incurred in order to calculate the true monetary impact of the sustainability practice.

The lifecycle of the practice comprises three phases:

1. Startup: All costs incurred to implement the practice.
2. O&M: All costs incurred in the normal day-to-day operations of the practice.
3. End of Life: All costs incurred when terminating and removing the practice at the end of its useful life.

Figure 14. General cost inputs guidance.
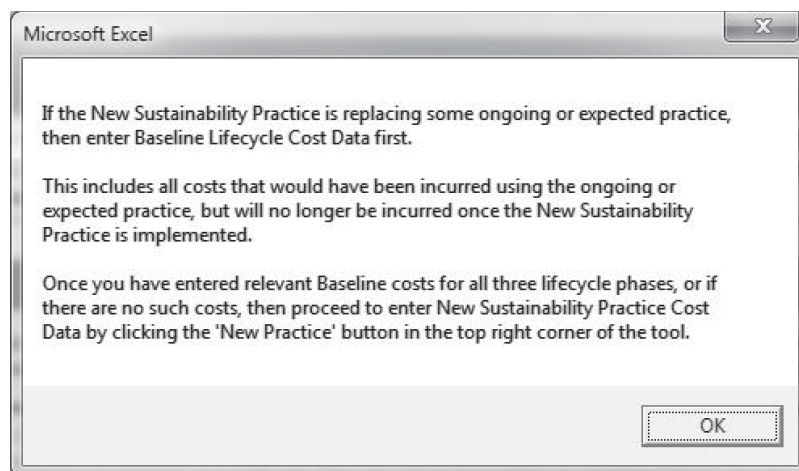
*Figure 15.   Proceed to enter new sustainability practice
cost data.*

Within each phase, users will enter baseline costs that currently are or are expected to be incurred at the airport but will not be incurred if replaced by the new sustainability practice. For instance, if the new sustainability practice involves switching from current light bulbs to LED light bulbs, then the normal replacement costs involved in replacing the current bulbs when they burn out should be included in the baseline costs. The direct costs of the sustainability practice will ultimately be subtracted from these baseline costs to find the net impact of the new practice. Therefore, if the baseline replacement cost of the current bulbs is entered by the user at $1,000 per year, and the replacement cost of the new LED bulbs is entered at $200 per year, then the tool will calculate the net savings from the sustainability practice to be $1,000 – $200 or $800 per year. If a current practice has reached the end of its lifecycle, and is expected to be re-implemented, then those costs should be included. If it is expected that, absent the new sustainability practice, no practice will be in place, then no baseline costs are relevant.

After the user has entered all relevant baseline costs, the tool allows the user to enter the lifecycle costs for the new sustainability practice. The user can add or edit baseline costs or new sustainability practice costs at any time.
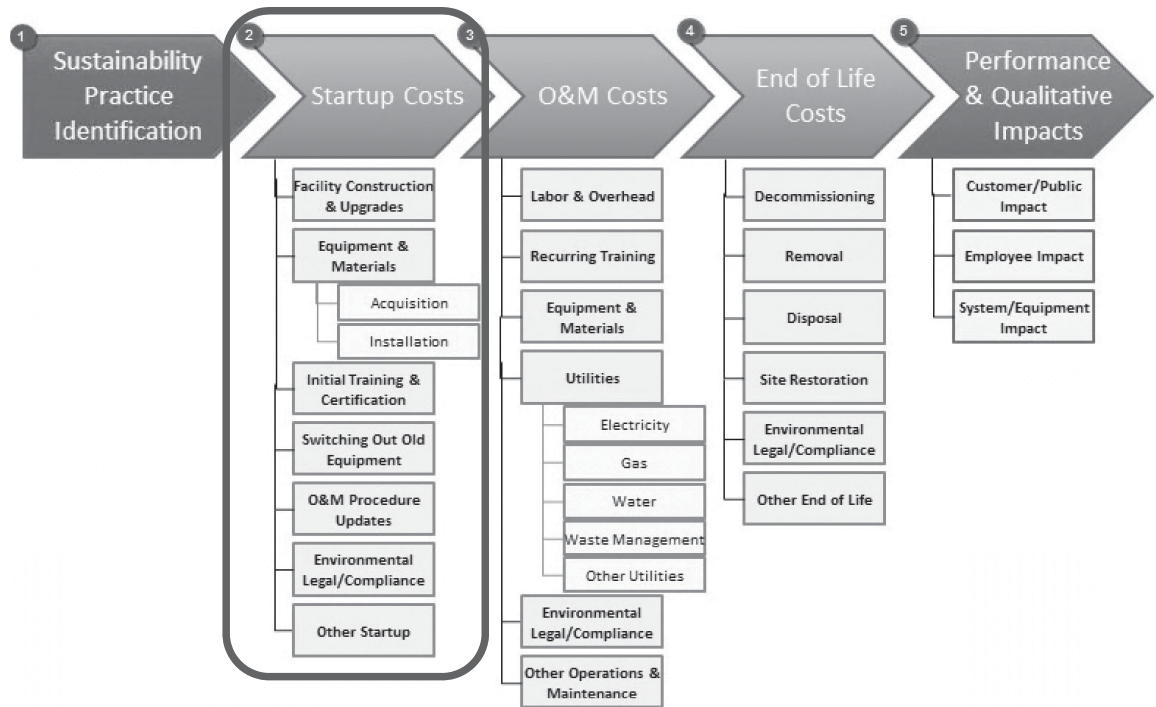
Figure 16.   Step 2 of the evaluation process.

Figure 17.
Previous/Next
buttons.

2.7.2.1 Startup Costs

The second step in the evaluation process, shown in Figure 16, is to input the startup costs. These costs include upfront costs associated with construction, equipment, training, legal requirements and compliance, and switching out old equipment for new equipment.

1. Selecting the blue Next arrow (Figure 17) on the right side of the spreadsheet takes the user to the *Startup* tab.
2. The *Baseline* button shown in Figure 18 is highlighted to indicate that the user is entering baseline costs.
3. Enter inputs in the relevant cost categories as shown in Figure 19. Each sustainability practice will be unique and may not require inputs for all categories. Categories should serve as guidelines and triggers to remind the user of previously unconsidered costs.

Figure 18.   Baseline button.

Figure 19.   Implementation support—cost categories.

a. When a relevant cost category is identified, click on the applicable gray box under the Available Cost Categories column. The selected cost category row will expand to show *Click to Add New Cost Item (Baseline)*, as shown in Figure 20.

b. Clicking on *Click to Add New Cost Item (Baseline)* will open the cost data entry form, shown in Figure 21, to allow the user to enter cost data. A detailed description of how to enter cost data is provided below.

Note: Cost category 2, Equipment & Materials, is split into 2.a, Acquisition, and 2.b, Installation, shown in Figure 20. Clicking on the *Acquisition* and *Installation* buttons allows the user to enter new cost items for the baseline scenario through the cost entry form (Figure 21), as described in the previous steps.

Figure 20.   Add new cost item.

Figure 21.   Enter cost data form.

c. Repeat this process for all relevant cost categories.

d. Clicking on the *Edit* button to the right of a previously entered cost item will bring up the cost data entry form, populated with previously entered data for that item, allowing the user to edit these inputs.

e. Clicking on the *Delete* button to the right of a previously entered cost item will allow the user to delete the cost item.

Note: At any time, the user can click on the *Help* button in the upper right-hand corner of the worksheet to open a help box, shown in Figure 22. The box provides the user with additional information on how to navigate through the *Startup Costs* sheet.

Cost Data Entry. The user can enter data about the cost item within the cost entry form. Information on each component of the cost data entry form is provided below:

1. *Enter Name of Cost:* Enter a unique name for the cost item.
2. *Select Cost Sub-Category:* Select a cost sub-category for the cost item. These categories map to a standard budget framework included in the Output section of the tool, and include the following:
   a. *Personnel:* Includes wages/hours, salaries, benefits, sick leave, hazard pay, travel and meal considerations, and anything else related to the workforce. Allocated overhead markups should be included, if applicable.
   b. *Material & Supplies:* Includes building or support materials, supplies, parts, and any other costs for materials and supplies. Use "Capital Outlay" for materials and supplies provided as part of a capital project.

Figure 22.   Startup Help.

 c. *Contractual Services:* Includes personal/professional services, project consulting, construction or waste removal contracts, and any other contractual services. Use "Capital Outlay" for services that are part of a capital project.

 d. *Operations:* Includes facility or infrastructure usage costs, management costs, and other operations costs related to performing these tasks.

 e. *Capital Outlay:* Includes acquisition of buildings or structures, infrastructure, equipment, and other capital costs related to performing these tasks.

 f. *Interdepartmental:* Includes usage fees and other costs related to performing these tasks that are paid to other departments within the airport.

 g. *Other Expenditures:* Includes any O&M department costs that do not fit into one of the above cost categories, but are related to performing these tasks.

3. *Enter Cost by Unit:* Costs can be entered either by unit or by year. By unit enables the user to build costs up from unit costs and payment schedules. The user enters:

 a. Range of years during which this cost item will be incurred, from the first year to the last year.

 b. Frequency with which the cost is incurred, whether one time only, or on a set schedule of years, months, or days.

 c. Unit type (e.g., hours, light bulbs); quantity of units (e.g., number of hours or units purchased); cost per unit (e.g., wage or unit price).

Figure 23. Cost Entry Help.
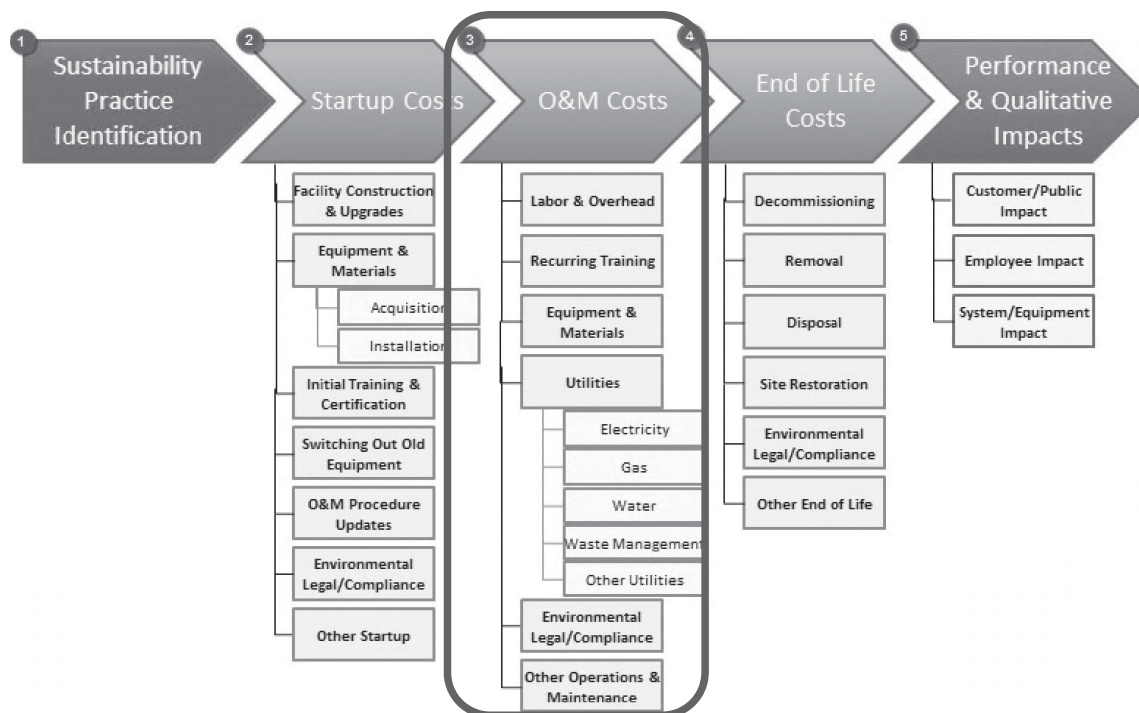
Figure 24.   Step 3 of the evaluation process.

Total costs in each year are then calculated from this information.

4. *Enter Total Costs by Year:* This method enables the user to enter total rolled up costs for the item in each year.

5. *Description of Cost Item and Impacts/Notes:* Enter a description or notes about the cost item, such as what exactly is included, any risks, etc.

The user must exit this form before continuing through the tool.

Note: Clicking on the *Help* button in the upper right corner of the cost entry form opens a window, shown in Figure 23, with further instructions on how to fill in the cost entry form.

Figure 25. Previous/Next button.

2.7.2.2 Operations & Maintenance Costs

The third step, shown in Figure 24, is to enter O&M costs. These are recurring O&M costs that are encountered throughout the major portion of the lifecycle, between implementation and disposal and decommissioning. These costs include personnel costs (part- and full-time staff and contractors), materials costs, utility costs, equipment or facility usage costs, opportunity costs, and any other costs incurred while operating and maintaining the new sustainability practice.

1. Selecting the blue Next arrow (Figure 25) on the right side of the spreadsheet takes the user to the *Operations & Maintenance* tab.

2. Enter inputs in the relevant cost categories shown in Figure 26. Each sustainability practice will be unique and may not require all categories. Categories should serve as guidelines and triggers to remind the user of previously unconsidered costs.

Figure 26.   O&M cost categories.

a. When a relevant cost category is identified, click on the appropriate gray box under the Available Cost Categories column. The selected cost category row will expand to show *Click to Add New Cost Item (Baseline)*, as shown in Figure 27.

b. Clicking on *Click to Add New Cost Item (Baseline)* will open the cost data entry form, shown previously in Figure 21, to allow the user to enter cost data for the baseline scenario.

Note: Cost category 4, Utilities, is split into 4.a, Electricity; 4.b, Gas; 4.c, Water; 4.d, Waste Management; and 4.e, Other Utilities, as shown in Figure 26. Clicking on the *Electricity*, *Gas*, *Water*, *Waste Management*, or *Other Utilities* buttons will allow the user to enter new cost items for the sustainability practice and for the baseline through the cost data entry form (Figure 21) as described in the previous steps.

c. Complete the cost entry process as previously described.

d. Repeat this process for all relevant cost categories.

Figure 27.   **Add New Cost Item.**

e. Clicking on the *Edit* button to the right of the entered cost item will bring up the cost entry form, populated with previously entered data for that item, allowing the user to edit it.

f. Clicking on the *Delete* button to the right of the entered cost item will allow the user to delete the cost item.

Note: At any time, the user can click on the *Help* button in the upper right-hand corner of the worksheet to open a help box, shown in Figure 28. The box provides the user with additional information on how to navigate through the *Operations and Maintenance* worksheet.

Figure 28.   O&M help screen.

Figure 29.   Step 4 of the evaluation process.

2.7.2.3 End of Life

The fourth step, shown in Figure 29, in the evaluation process is entering end of life costs. This is the final phase of the lifecycle and includes dismantling and disposal costs, site restoration costs, legal and compliance costs, and any other costs incurred while switching out the baseline scenario or new sustainability practice at the end of its lifecycle.

1. Selecting the blue Next arrow (Figure 30) on the right side of the spreadsheet takes the user to the *End of Life* tab.
2. Enter inputs in the relevant cost categories as shown in Figure 31. Each sustainability practice will be unique and may not require all categories. Categories should serve as guidelines and triggers to remind the user of previously unconsidered costs.
   a. Click on a gray box under the Available Cost Categories column. The selected cost category row will expand to show *Click to Add New Cost Item (Baseline)*, as shown in Figure 32.
   b. Clicking on *Click to Add New Cost Item (Baseline)* will open the cost data entry form, shown previously in Figure 21, to allow the user to enter cost data for the baseline scenario.
   c. Repeat this process for all relevant cost categories.
   d. Clicking on the *Edit* button to the right of the entered cost item will bring up the cost data entry form, populated with previously entered data for that item, allowing the user to edit it.
   e. Clicking on the *Delete* button to the right of the entered cost item will allow the user to delete the cost item.

Note: At any time, the user can click on the *Help* button in the upper right-hand corner of the worksheet to open a help box, shown in Figure 33. The box provides the user with additional information on how to navigate through the *End of Life* worksheet.

Figure 30. Previous/Next button.
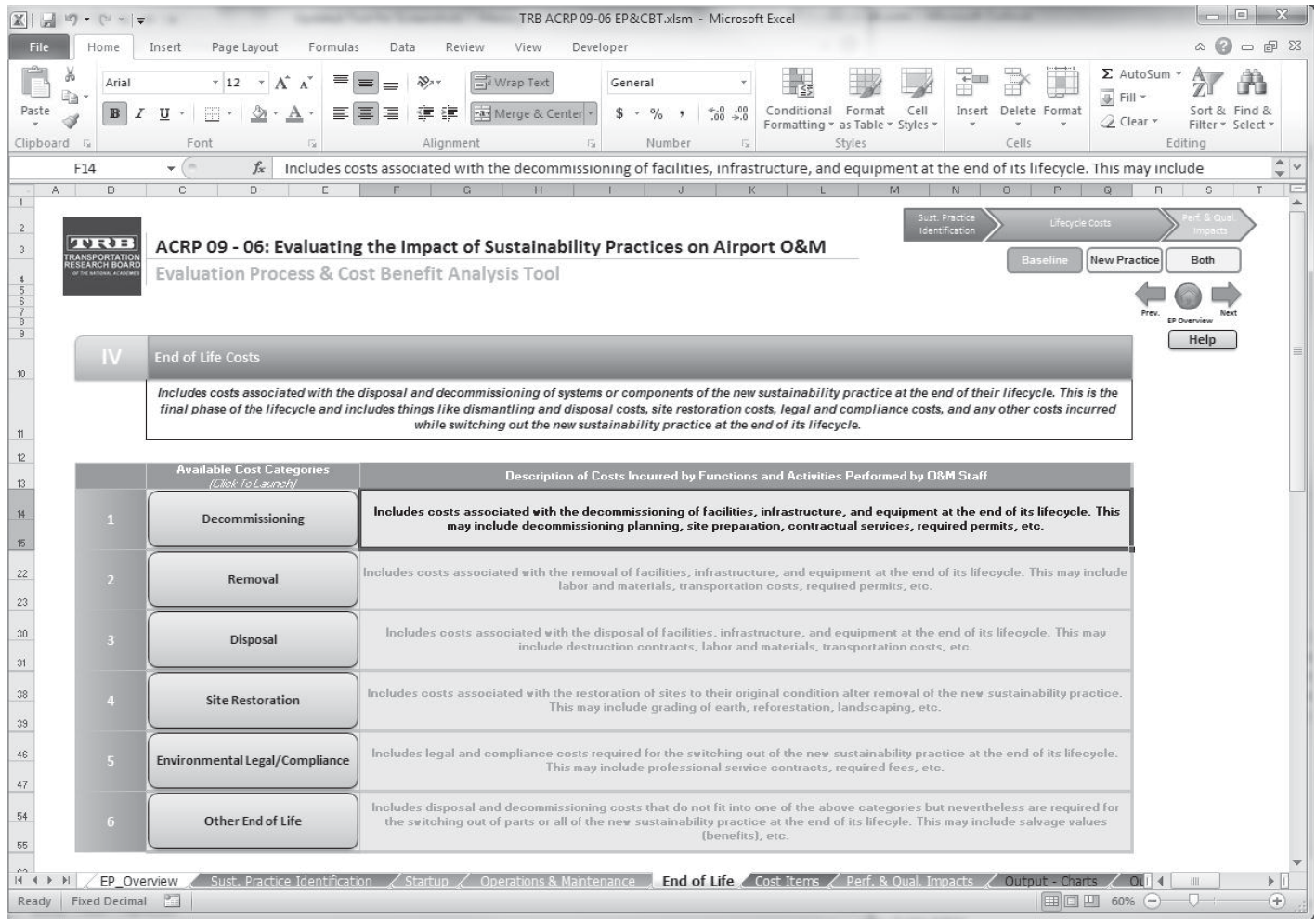
Figure 31.   End of Life—cost categories.

Figure 32.   Decommissioning—add new cost item.

Figure 33.   End of Life *help screen.*

2.7.2.4 New Sustainability Practice Costs

Once the user has entered all relevant baseline scenario costs, the user should then enter all relevant lifecycle costs for the new sustainability practice in the same manner as was done for the baseline costs. To enter costs for the new practice, the user can return to the *Startup* tab by clicking the blue *Next* arrow on the right side of the *End of Life* spreadsheet. The user can also click the *New Practice* button at the top right of the page, as shown in Figure 34. The user will be taken to the *Startup* tab, and a box, shown in Figure 35, will open, prompting the user to enter all relevant costs for the new sustainability practice.

After entering all relevant lifecycle costs for the new sustainability practice, clicking the blue *Next* arrow on the right side of the *End of Life* spreadsheet will take the user to the *Cost Items* tab. The user can return to the Lifecycle Costs tabs at any point to edit or delete cost items for the baseline scenario or the sustainability practice. Clicking on the *Baseline* and *New Practice* buttons at the top right of each of the lifecycle cost pages will allow the user to switch between viewing baseline and new practice data, and the *Both* button will enable the user to see cost items for both the baseline and the new practice.
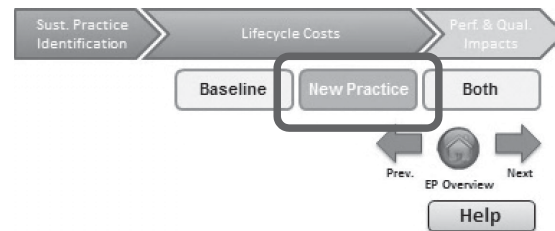
Figure 34.   **New Practice *button.***
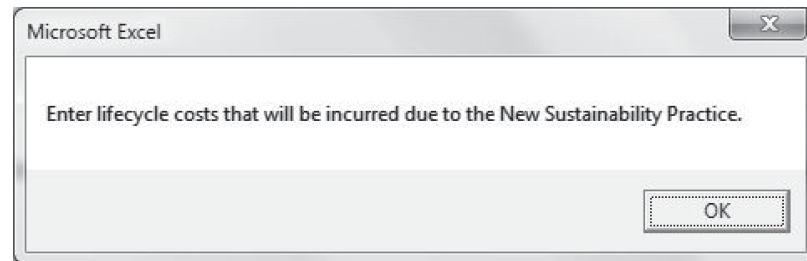
Figure 35.   **Prompt to enter data on new sustainability practice.**

2.7.3 Cost Items

The *Cost Items* tab provides the user with a list of the lifecycle cost items entered throughout the Lifecycle Costs input tabs, including both the new sustainability practice costs and baseline costs. The list provides an intuitive summary of all of the identified impacts and can serve as an additional "memory jogger" to help the user identify potential impacts not yet input, at which point the user can return to the Inputs tabs and add these additional impacts.

1. From the *End of Life* tab, select the blue *Next* arrow (Figure 36) on the right side of the spreadsheet, which takes the user to the *Cost Items* tab.
2. The summary of cost items table, shown in Figure 37, summarizes the costs that have been entered throughout the Lifecycle Costs input tabs.

2.7.4 Performance & Qualitative Impacts

The fifth and final step in the evaluation process, shown in Figure 38, is for the user to enter performance and qualitative impacts. The purpose of this last component is to identify

Figure 36.
Previous/Next button.

		Sustainability Practice Cost Item Identification				Sustainability Practice Costs by Units							
Cost ID	Name	Description	Lifecycle Phase	Cost Category	Cost Subcategory	Unit Type	Quantity	$/Unit	Total $	Frequency	Cost Cycle	Initial Year	End Year
1	LED Lighting Initial Fixture Purchase	This includes the cost to purchase the new LED fixtures that will be installed.	Startup	Equipment & Materials Acquisition	Materials & Supplies	Fixtures	210	639	134190		One Time Cost	1	1
2	LED Lighting Initial Installation	This is the total cost for removing the old fixtures, installing a hook and plug and installing the new fixtures. A labor rate of $35 per hour including benefits is assumed.	Startup	Equipment & Materials Installation	Personnel	Hours	210	600	126000		One Time Cost	1	1
3	LED Circuit Maintenance Training	This includes the time spent training electrical maintenance staff on the use and maintenance of LED circuitry. 4 electricians are included in the training session at $35 per hour.	Startup	Initial Training & Certification	Personnel	Hours	4	140	560		One Time Cost	1	1
4	LED Lighting Replacement Labor	This includes the hours that will be spent repacing the LED lightbulbs when they die. Based on their lifespan, these bulbs will be replaced once every 10 years. A labor rate of $35 per hour including benefits is assumed.	Operations & Maintenance	Labor & Overhead	Personnel	Hours	210	210	44100	10	Years	1	20
5	LED Lighting Replacement Bulbs	This includes the cost to purchase new bulbs for replacing the LED lightbulbs when they die. Based on their lifespan, these bulbs will be replaced once every 10 years.	Operations & Maintenance	Equipment & Materials	Materials & Supplies	Bulbs	210	639	134190	10	Years	1	20
6	Electricity Cost New Practice		Operations & Maintenance	Electricity	Operations	Cost	210	56	11760	1	Years	1	20

		Baseline Cost Item Identification				Baseline Costs by Units							
Cost ID	Name	Description	Lifecycle Phase	Cost Category	Cost Subcategory	Unit Type	Quantity	$/Unit	Total $	Frequency	Cost Cycle	Initial Year	End Year
1	Current Lighting Replacement Labor	This includes the hours that would be spent replacing the current bulbs when they die. Based on their lifespan, these bulbs are replaced every two years. A labor rate of $35 per hour including benefits is assumed.	Operations & Maintenance	Labor & Overhead	Personnel	Hours	210	140	29400	2	Years	1	20
2	Current Lighting Replacement Bulbs	This includes the cost to purchase new bulbs for replacing the current bulbs when they die. Based on their lifespan, these bulbs are replaced twice each year. A labor rate of $35 per hour including benefits is assumed.	Operations & Maintenance	Equipment & Materials	Materials & Supplies	Bulbs	210	100	21000	2	Years	1	20
3	Electricity Cost Baseline		Operations & Maintenance	Electricity	Operations	Cost	210	202	42420	1	Years	1	20

Figure 37.   Summary of cost items.
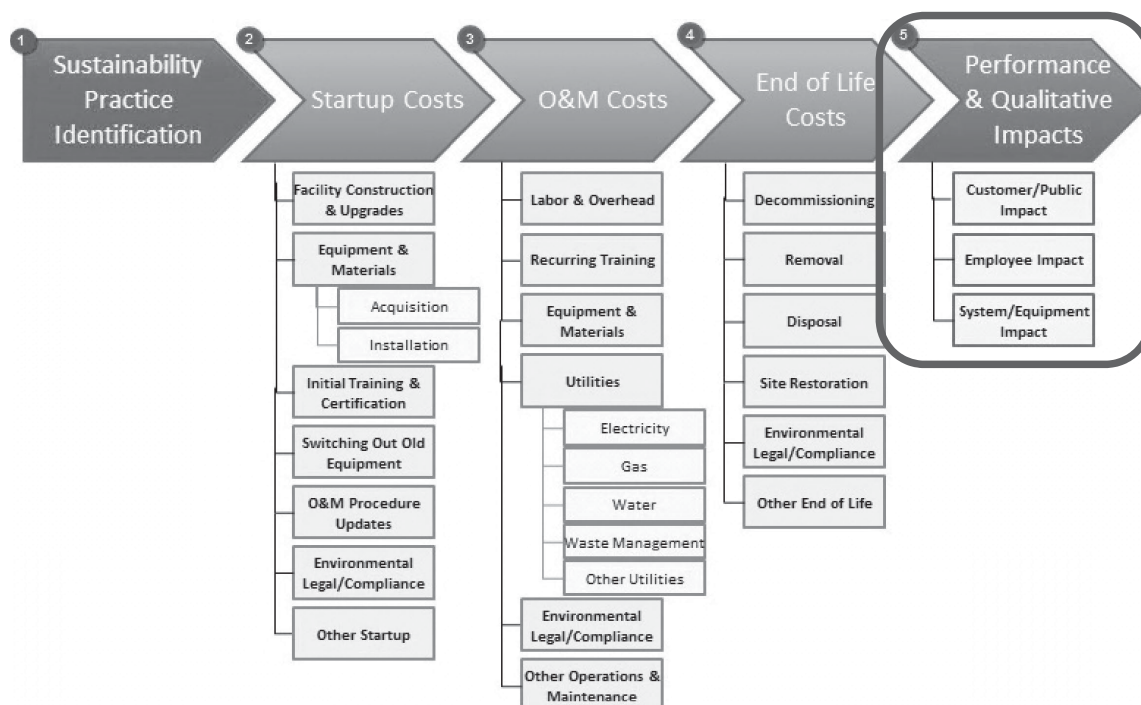
Figure 38.   Step 5 in the evaluation process.

**Figure 39.
Previous/Next
button.**

impacts to customer experience, safety and health of customers and employees, recognition as a leader of environmental management and practice, procedural impacts, and other aspects that are not considered as part of the lifecycle costs. It includes all relevant impacts that were not captured during the Startup, Operations & Maintenance, and End of Life cost sections.

1. Selecting the blue Next arrow (Figure 39) on the right side of the spreadsheet takes the user to the *Perf. & Qual. Impacts* tab.
2. This worksheet provides standard impacts that are prepopulated in the tool and also allows the user to enter customized impacts (e.g., airport-specific core values). Enter inputs in each of the relevant categories as shown in Figure 40.
   a. When a relevant category is identified, click on the appropriate gray box under the Available Categories column. The selected category row will expand to show a set of standard impacts, as shown in Figure 41.
   b. Clicking on the *Edit* button to the right of a standard impact will bring up the form, shown in Figure 42, to allow the user to enter performance and qualitative data. The user can select the desired impact rating (Positive, Neutral, or Negative) from the pull-down list next to *Enter Impact Rating* to identify the impact that the sustainability practice will have on this category. The user can also edit the description to provide detailed information about the relevant impact.
   c. From the screen shown in Figure 41, the user can input customized impacts by clicking on the *Click to Add Performance & Qualitative Impact* to bring up a blank form of Figure 42. Enter a name, rating, and detailed description of the custom impact. To save a customized impact, click *Save Impact* at the bottom of the form. "Impact Saved Successfully" will appear in the bottom left corner of the form. Custom impacts can be edited or deleted
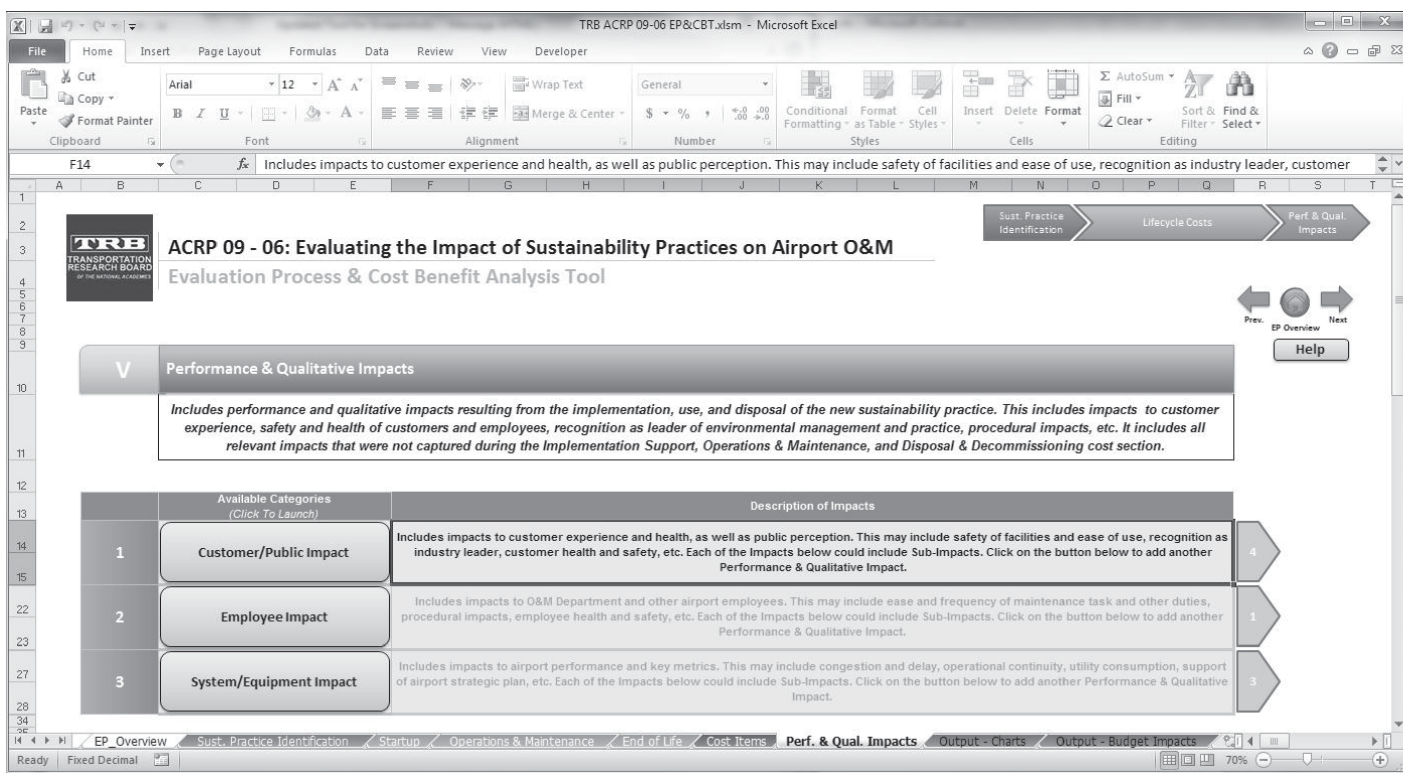
Figure 40.   Screen showing cost categories for performance & qualitative impacts.

Figure 41. Screen showing standard impacts and how to add new impacts.

Figure 42. Screen for editing performance and qualitative impacts.
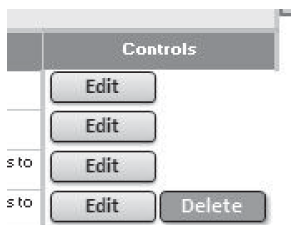
Figure 43. **Edit** *and* **Delete** *buttons for custom impacts.*

subsequently by clicking on the *Edit* or *Delete* buttons next to the custom impact, as shown in Figure 43.

d. Repeat this process for all relevant performance and qualitative impacts.

Note: At any time, the user can click on the *Help* button in the upper right-hand corner of the worksheet to open a help box, shown in Figure 44. The box provides the user with additional information on how to navigate through the *Performance & Qualitative Impacts* worksheet.

2.8 Outputs

2.8.1 Output – Charts

Once all of the information about the new sustainability practice is entered, the output charts will be populated and a graphical summary of impacts of the sustainability practice can be viewed. This includes the summary of the O&M costs and benefits of implementing the new sustainability practice. Users of Microsoft Excel 2007 will not be able to see these charts.

The graphical output provides cost summaries and graphics showing the impacts of implementing the sustainability practice in terms of key O&M cost metrics. It provides the user with simple charts that summarize the key impacts of the sustainability practice. It also provides a graphical output for the Performance & Qualitative Impacts, displaying a list of the identified impacts and a graphical representation of their impact levels.
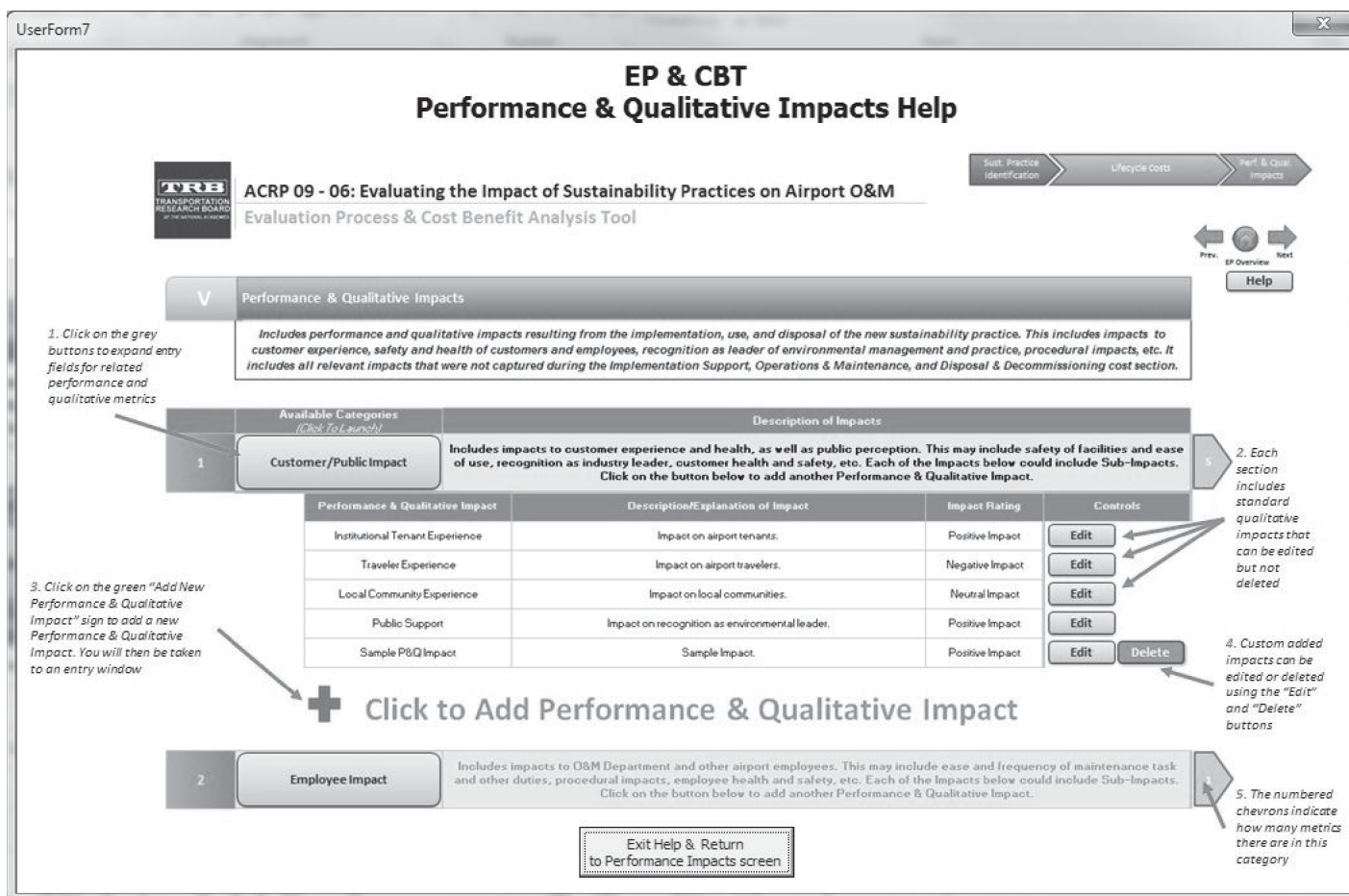
Figure 44. **Help** *screen for Performance & Qualitative Impacts.*

The output charts can be accessed by selecting the blue *Next* arrow (Figure 45) on the right side of the spreadsheet or clicking on the *Output – Charts* tab.

A summary of the cost–benefit analysis is presented in table format (Figure 46). This summary includes a description of the impacts of the sustainability practice, as well as the total O&M costs of the sustainability practice, the total net cost or savings of the sustainability practice compared to the baseline scenario, the cumulative NPV over the analysis period, and the return on investment (ROI) over the analysis period.

A graphical summary of the cost–benefit analysis is also displayed, as shown in Figure 47. It shows the total baseline costs by year, total sustainability practice costs by year, and the NPV of implementing the practice. The total costs bars provide the user information on

Figure 45. Previous/Next button.

Summary description of Sutainability Practice to be implemented					
Summary of the evaluation of the O&M costs and benefits of implementing the sustainability practice Terminal Lighting Upgrade at Example Airport. This practice falls under the category of Energy Conservation, and will cause impacts to Terminal Buildings and Concourses, and Taxi, Bus, Limo Staging and Buildings, over a 20 year period.					

Summary of Cost Benefit Analysis					
Total O&M Costs of Sustainability Practice	Total Net Benefits of Sustainability Practice (vs. Baseline)	Cumulative NPV (over period of analysis)	ROI (%, over period of analysis)	Break Even Point (years to positive ROI)	
$674,240	$678,160	$272,163	101%	6 Years	

Figure 46.   Screen showing the summary of a cost–benefit analysis.
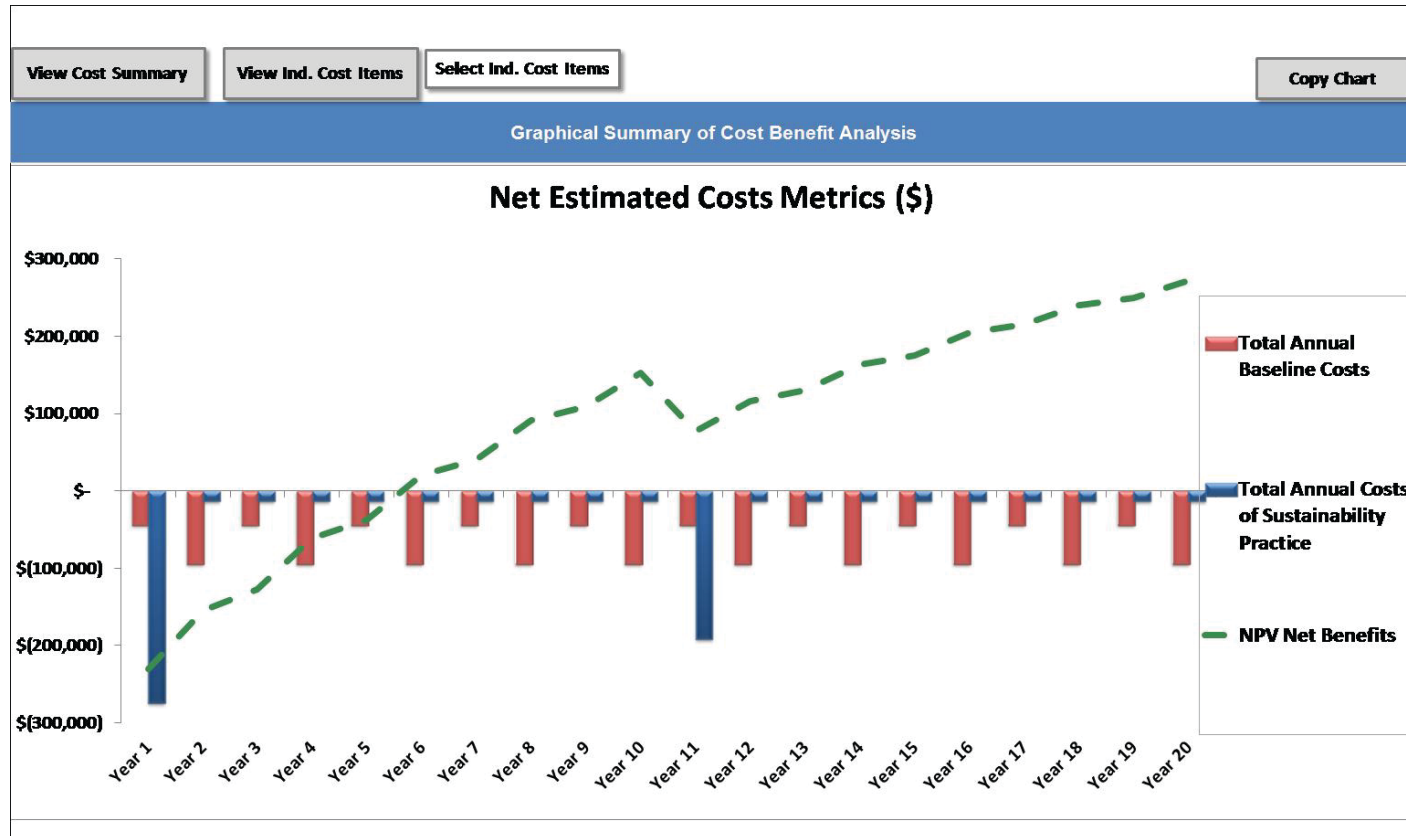
Figure 47.   Screen of the graphical summary of a cost–benefit analysis.

how the practice will impact O&M costs each year, while the NPV calculation provides a value of the impacts of the practice throughout its lifecycle, based on the user-provided discount rate. This information can be used by the user to assess the viability of implementing the sustainability practice or to compare the sustainability practice to other potential practices.

1. The user can also view the costs of individual cost items, for instance to compare utility costs between baseline and the sustainability practice. Clicking on the white *Select Ind. Cost Items* button above the Graphical Summary of Cost Benefit Analysis graph will bring up the cost item selection screen shown in Figure 48, allowing the user to add or remove available cost items to be displayed on the graph.
2. The user can switch between viewing the cost summary and selected individual cost items by clicking the gray *View Cost Summary* or *View Ind. Cost Items* buttons above the graph. The user can also make a copy of the graphical summary by clicking on the *Copy Chart* button above the graph on the right (Figure 47).

A summary of the performance and qualitative impacts is displayed in the orange box, as shown in Figure 49.

Note: At any time, the user can click on the *Help* button in the upper right-hand corner of the worksheet to open a help box, shown in Figure 50. The box provides the user with additional information on how to navigate through the *Output – Charts* worksheet.

2.8.2 Output – Budget Impacts

The *Output – Budget Impacts* section provides all of the identified costs rolled up into a standard budget framework. This includes the costs due to the sustainability practice, baseline costs, and net costs, which are defined as the costs of the sustainability practice minus the baseline costs, as well as NPV calculations.

Figure 48.   Screen for selecting individual cost items to chart.

Figure 49.   Screen summarizing the performance and qualitative impacts.

Figure 50.   Help screen for Output – Charts.

**Figure 51.
Previous/Next
button.**

The budget impacts output can be accessed by selecting the blue *Next* arrow (Figure 51) on the right side of the spreadsheet or clicking on the *Output – Budget Impacts* tab.

The Summary of Economic Analysis table shown in Figure 52 (using an example sustainability practice) provides high-level summaries of the data, including total costs and NPV calculations.

The budget is broken down into seven categories:

1. Personnel
2. Materials & Supplies
3. Contractual Services
4. Operating Expenditures
5. Capital Outlay
6. Interdepartmental
7. Other

The blue table in the worksheet (Figure 53) summarizes the costs of the new sustainability practice (using the installation of LED light bulbs as an example). The red table in the worksheet (Figure 54) summarizes the costs of the baseline scenario. The green table in the worksheet (Figure 55) summarizes the net costs/benefits of the new sustainability practice and the baseline scenario. Each of these tables uses the number of years defined by the user in the *Sust. Practice Identification* tab as the period of analysis.

2.9 How to Use the EP&CBT Results

The *Output* section of the tool enables the user to view the impacts of the sustainability practice in two ways:

- Budget output
- Graphical output

2.9.1 Budget Output

The budget output provides all of the identified costs rolled up into a standard budget framework. This includes the costs due to the new sustainability practice, baseline costs, and net costs. The project team developed this framework based on the case study airport interviews and a comparison between budget frameworks provided by different airports. The *Output Budget* provides a standard method for viewing the monetary impacts produced by the sustainability practice and also organizes the data in a way that is familiar to airports. The budget is broken down into seven categories:

Calculated Values for Sustainability Practice to be Implemented ($)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Total Annual Costs of Sustainability Practice	$ (5,400)	$ (200)	$ (200)	$ (200)	$ (200)	$ (200)	$ (200)	$ (200)	$ (200)	$ (200)
Total Annual Baseline Costs	$ (1,150)	$ (1,150)	$ (1,150)	$ (1,150)	$ (1,150)	$ (1,150)	$ (1,150)	$ (1,150)	$ (1,150)	$ (1,150)
Total Annual Net Benefits	$ (4,250)	$ 950	$ 950	$ 950	$ 950	$ 950	$ 950	$ 950	$ 950	$ 950
Cumulative NPV Sustainability Practice	$ (5,047)	$ (5,221)	$ (5,385)	$ (5,537)	$ (5,680)	$ (5,813)	$ (5,938)	$ (6,054)	$ (6,163)	$ (6,265)
Cumulative NPV Baseline	$ (1,075)	$ (2,079)	$ (3,018)	$ (3,895)	$ (4,715)	$ (5,482)	$ (6,198)	$ (6,867)	$ (7,493)	$ (8,077)
Cumulative NPV Net	$ (3,972)	$ (3,142)	$ (2,367)	$ (1,642)	$ (965)	$ (332)	$ 260	$ 813	$ 1,330	$ 1,813

Figure 52.   Screen showing the summary of an economic analysis of a sustainability practice.

- Costs of Sustainability Practice -						
Calculated Values (FY $)		Year 1	Year 2	Year 3	Year 4	Year 5
Personnel	Installation of LED Light Bulbs	$ 100.00	$ -	$ -	$ -	$ -
	Removal of Old Lightbulbs	$ 100.00	$ -	$ -	$ -	$ -
	Replacement of LED Lightbulbs	$ -	$ -	$ -	$ -	$ -
Total Personnel		$ 200.00	$ -	$ -	$ -	$ -
Material & Supplies	Purchase of New LED Light Bulbs	$ 5,000.00	$ -	$ -	$ -	$ -
	Purchase Replacement LED Lightbulb	$ -	$ -	$ -	$ -	$ -
Total Material & Supplies		$ 5,000.00	$ -	$ -	$ -	$ -
Contractual Services						
Total Contractual Services		$ -	$ -	$ -	$ -	$ -
Operating Expenditures	Electricity for LED Lightbulbs	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00
Total Operating Expenditures		$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00
Capital Outlay						
Total Capital Outlay		$ -	$ -	$ -	$ -	$ -
Interdepartmental						
Total Interdepartmental		$ -	$ -	$ -	$ -	$ -
Other Expenditures						
Total Other Expenditures		$ -	$ -	$ -	$ -	$ -
NPV (Annual)		$ 5,046.73	$ 174.69	$ 163.26	$ 152.58	$ 142.60
NPV (Cumulative)		$ 5,046.73	$ 5,221.42	$ 5,384.68	$ 5,537.26	$ 5,679.85

Figure 53.   Screen of the Detailed O&M Budget View—Costs of Sustainability Practice.

1. Personnel
2. Materials & Supplies
3. Contractual Services
4. Operating Expenditures
5. Capital Outlay
6. Interdepartmental
7. Other

As each airport is different in the way it organizes and records costs, this standard budget may not be equivalent to current budgets at each airport, but it does provide a clear way to compare different sustainability practices and a conventional framework for viewing costs. A sample output budget is shown in Figure 56.

2.9.2 Graphical Output

The graphical output provides cost summaries and graphics showing the impacts of implementing sustainability practices in terms of key O&M cost metrics. It provides the user with simple charts that summarize the key impacts of the new sustainability practice. It

- Baseline Costs -		Year 1	Year 2	Year 3	Year 4	Year 5
Calculated Values (FY $)						
Personnel	Replacement of Current Lightbulbs	$ 100.00	$ 100.00	$ 100.00	$ 100.00	$ 100.00
Total Personnel		$ 100.00	$ 100.00	$ 100.00	$ 100.00	$ 100.00
Materials & Supplies	Purchase of Replacement Standard L	$ 50.00	$ 50.00	$ 50.00	$ 50.00	$ 50.00
Total Material & Supplies		$ 50.00	$ 50.00	$ 50.00	$ 50.00	$ 50.00
Contractual Services						
Total Contractual Services		$ -	$ -	$ -	$ -	$ -
Operations	Electricity for old Lightbulbs	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00
Total Operating Expenditures		$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00
Capital Outlay						
Total Capital Outlay		$ -	$ -	$ -	$ -	$ -
Inter-Departmental Expenditures						
Total Interdepartmental		$ -	$ -	$ -	$ -	$ -
Other Expenditures						
Total Other Expenditures		$ -	$ -	$ -	$ -	$ -
NPV (Annual)		$ 1,074.77	$ 1,004.45	$ 938.74	$ 877.33	$ 819.93
NPV (Cumulative)		$ 1,074.77	$ 2,079.22	$ 3,017.96	$ 3,895.29	$ 4,715.23

Figure 54.   Screen of the Detailed O&M Budget View—Baseline Costs.

- Net Benefits -	Year 1	Year 2	Year 3	Year 4	Year 5
Calculated Values (FY $)					
Total Personnel	$ (100.00)	$ 100.00	$ 100.00	$ 100.00	$ 100.00
Total Material & Supplies	$ (4,950.00)	$ 50.00	$ 50.00	$ 50.00	$ 50.00
Total Contractual Services	$ -	$ -	$ -	$ -	$ -
Total Operating Expenditures	$ 800.00	$ 800.00	$ 800.00	$ 800.00	$ 800.00
Total Capital Outlay	$ -	$ -	$ -	$ -	$ -
Total Interdepartmental	$ -	$ -	$ -	$ -	$ -
Total Other Expenditures	$ -	$ -	$ -	$ -	$ -
NPV (Annual)	$ (3,971.96)	$ 829.77	$ 775.48	$ 724.75	$ 677.34
NPV (Cumulative)	$ (3,971.96)	$ (3,142.20)	$ (2,366.71)	$ (1,641.96)	$ (964.63)

Figure 55.   Screen of the Detailed O&M Budget View—Net Benefits.

- Costs of Sustainability Practice -		Year 1	Year 2	Year 3	Year 4	Year 5
Calculated Values (FY $)						
Personnel	LED Lighting Initial Installation	$ 126,000.00	$ -	$ -	$ -	$ -
	LED Circuit Maintenance Training	$ 560.00	$ -	$ -	$ -	$ -
	LED Lighting Replacement Labor	$ -	$ -	$ -	$ -	$ -
Total Personnel		$ 126,560.00	$ -	$ -	$ -	$ -
Material & Supplies	LED Lighting Initial Fixture Purchase	$ 134,190.00	$ -	$ -	$ -	$ -
	LED Lighting Replacement Bulbs	$ -	$ -	$ -	$ -	$ -
Total Material & Supplies		$ 134,190.00	$ -	$ -	$ -	$ -
Contractual Services						
Total Contractual Services		$ -	$ -	$ -	$ -	$ -
Operating Expenditures	Electricity Cost New Practice	$ 11,760.00	$ 11,760.00	$ 11,760.00	$ 11,760.00	$ 11,760.00
Total Operating Expenditures		$ 11,760.00	$ 11,760.00	$ 11,760.00	$ 11,760.00	$ 11,760.00
Capital Outlay						
Total Capital Outlay		$ -	$ -	$ -	$ -	$ -
Interdepartmental						
Total Interdepartmental		$ -	$ -	$ -	$ -	$ -
Other Expenditures						
Total Other Expenditures		$ -	$ -	$ -	$ -	$ -
NPV (Annual)		$ 272,510.00	$ 10,990.65	$ 10,271.64	$ 9,599.66	$ 8,971.65
NPV (Cumulative)		$ 272,510.00	$ 283,500.65	$ 293,772.29	$ 303,371.96	$ 312,343.60

Figure 56.   Sample budget output.

also provides a graphical output for the Performance & Qualitative Impacts, displaying a list of the identified impact (ordered by user-defined impact levels), and a graphical representation of that impact level. Table 2 shows the key metrics that are included in the graphical output.

The collection of metrics provides a variety of ways to view the impacts of implementing the sustainability practice, each serving a different purpose. A summary of the evaluation of the O&M costs and benefits of implementing the sustainability practice is provided in the *Output – Charts* tab of the tool. An example of the summary total costs output graph is shown in Figure 57. This summary includes the total O&M costs of the sustainability practice, the total net costs or savings of the new sustainability practice compared to the baseline scenario, the cumulative NPV over the analysis period, and the ROI over the analysis period.

The user can graphically view and compare cost outputs for individual items identified within the lifecycle costs. This enables the user to quickly identify major cost contributors and gain an in-depth understanding of how individual costs are contributing to the total costs of the practice. A sample cost graph comparing two cost items is shown in Figure 58.

Table 2.   Key metrics included in graphical output.

Key Metric	Sample Use
Net Present Value (NPV)	Assess the overall profitability of the sustainability practice taking discount rate into account
Return on Investment (ROI)	Relate the benefit of the new sustainability practice to its cost
Total Costs	Evaluate yearly impacts and compare operating costs between sustainability practices
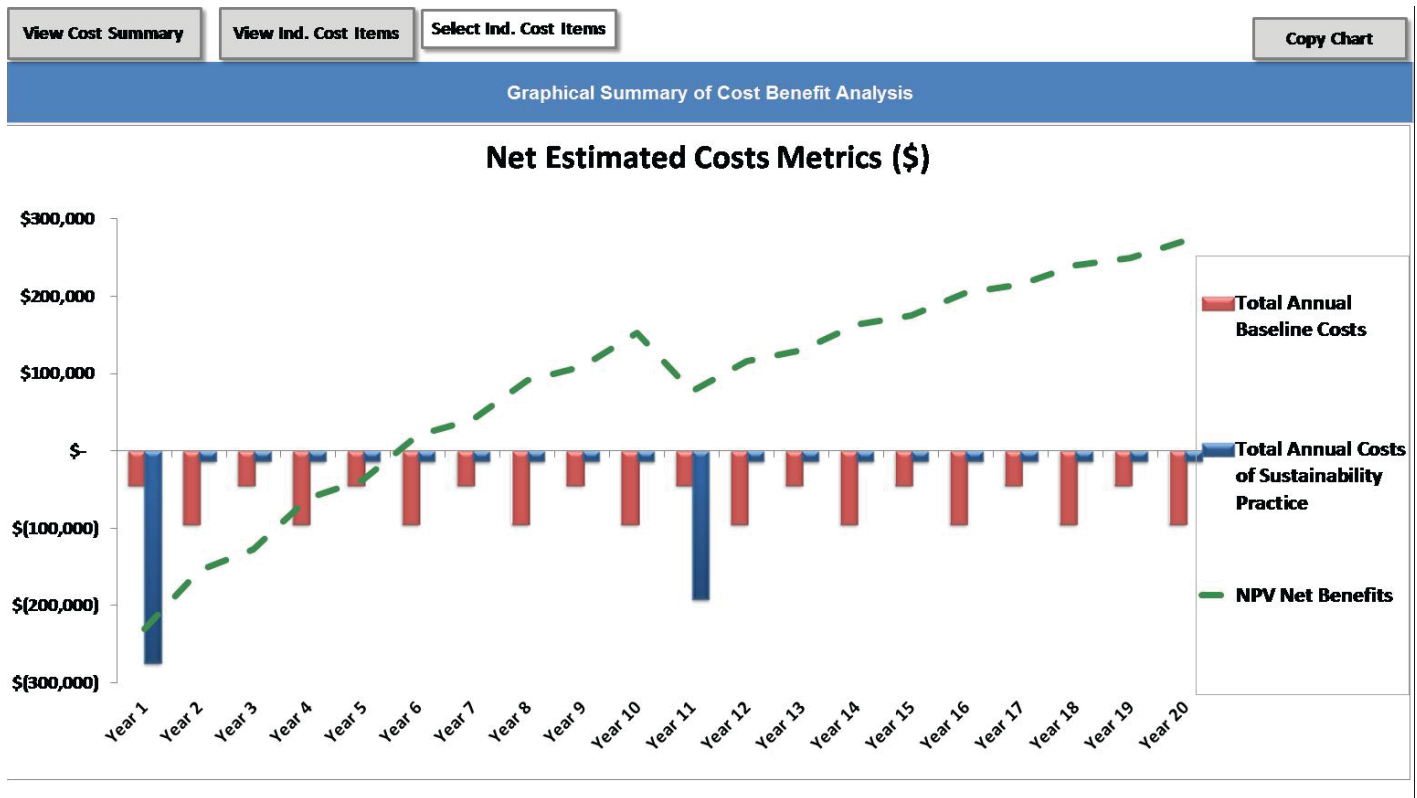
Figure 57.   Graphical summary of cost–benefit analysis.
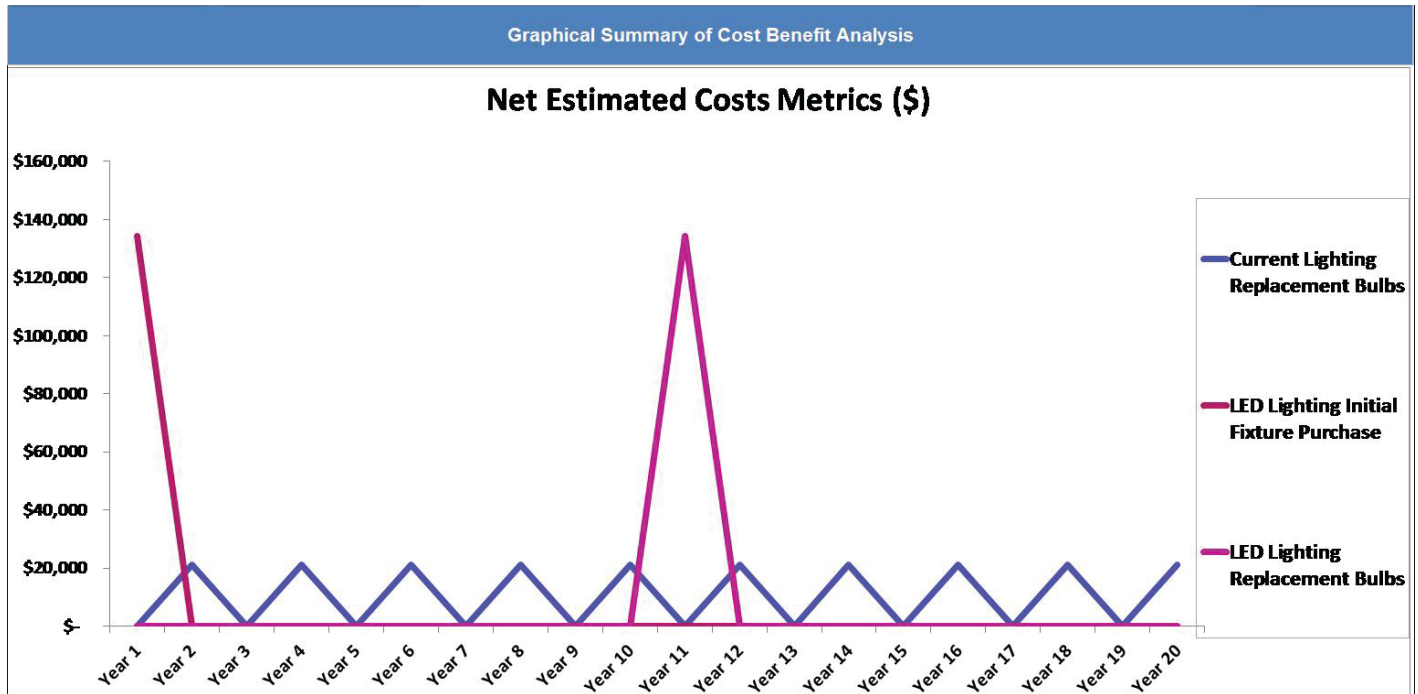
Figure 58.   Output graph of individual costs.

The performance and qualitative impacts identified in the inputs section are presented here to show the major impact areas (see Figure 59). While unassociated with cost information, these impacts provide valuable insight into the overall impact of the sustainability practice. The green bars correspond to a positive impact and the red bars correspond to a negative impact.

Figure 59.   Major impact areas of performance and qualitative impacts.

2.10 Troubleshooting

Some difficulties may arise during use of the EP&CBT. Some common warnings/errors and their solutions are provided in the following sections.

2.10.1 Enabling Macros

2.10.1.1 Security Warning

The EP&CBT uses a variety of macros to enable the user to evaluate a sustainability practice. MS Excel has multiple macro settings that determine how macros are enabled and how the user is notified. The macros in the EP&CBT must be enabled for the tool to function properly. By default, MS Excel disables macros but notifies the user of this security feature. When opening the EP&CBT for the first time (or a saved version of the EP&CBT with data entered), MS Excel will display a security warning, as shown in Figure 60. Click *Enable Content* to enable full functionality of the EP&CBT.

2.10.1.2 Error Message

When using the EP&CBT, the user receives the message shown in Figure 61. MS Excel is set to disable macros without notifying the user. Macros will need to be enabled for the EP&CBT to work properly.
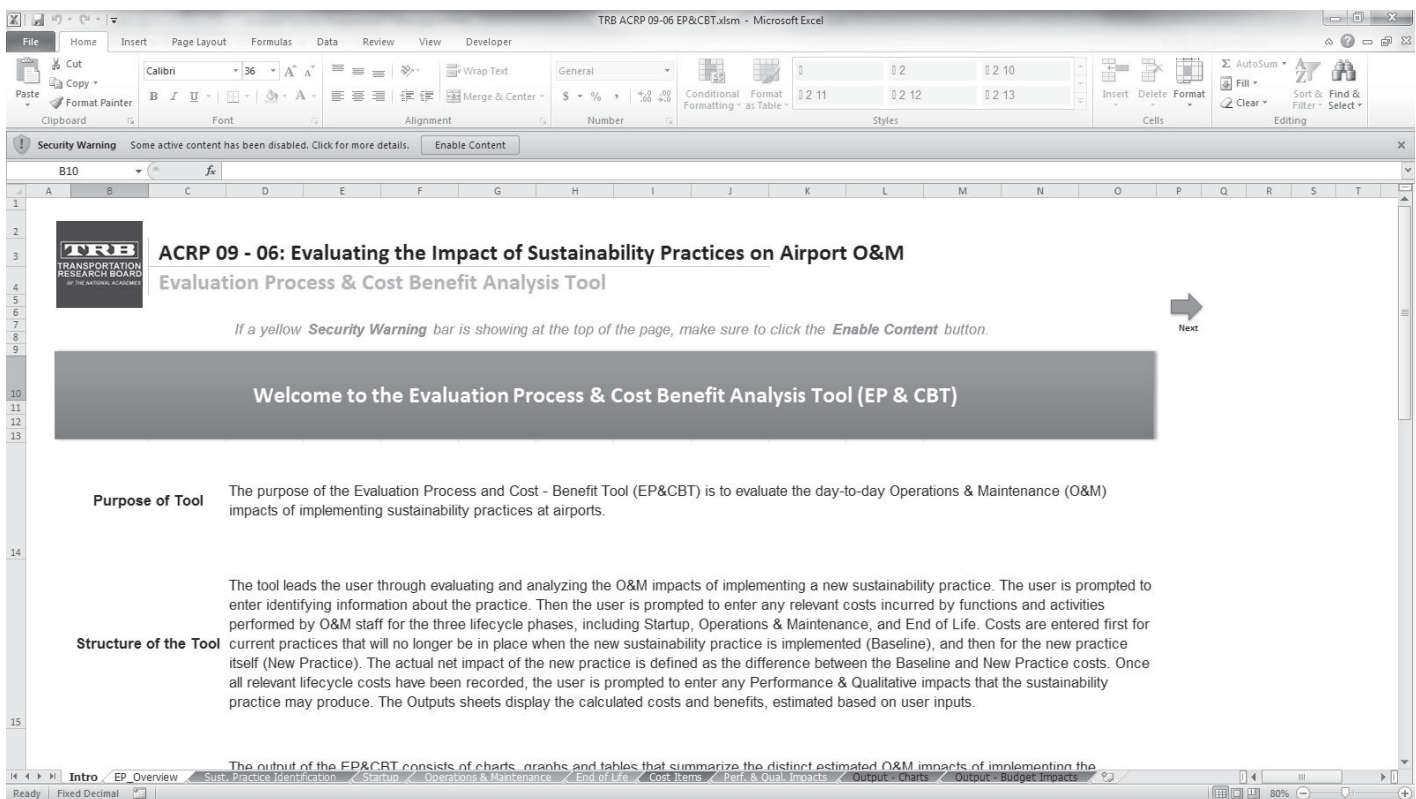
Figure 60.   Screen showing the MS Excel security warning.
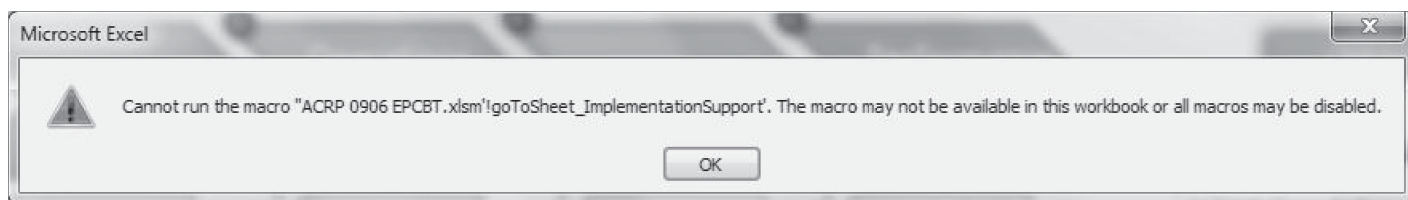
Figure 61.   Screen of MS Excel error message.

To change Macro Settings in MS Excel 2010:

1. Click *File* > *Options* to bring up the Excel Options window.
2. In the left-hand column of this window, click *Trust Center*, then choose *Trust Center Settings*, shown in Figure 62, to bring up the window shown in Figure 63.
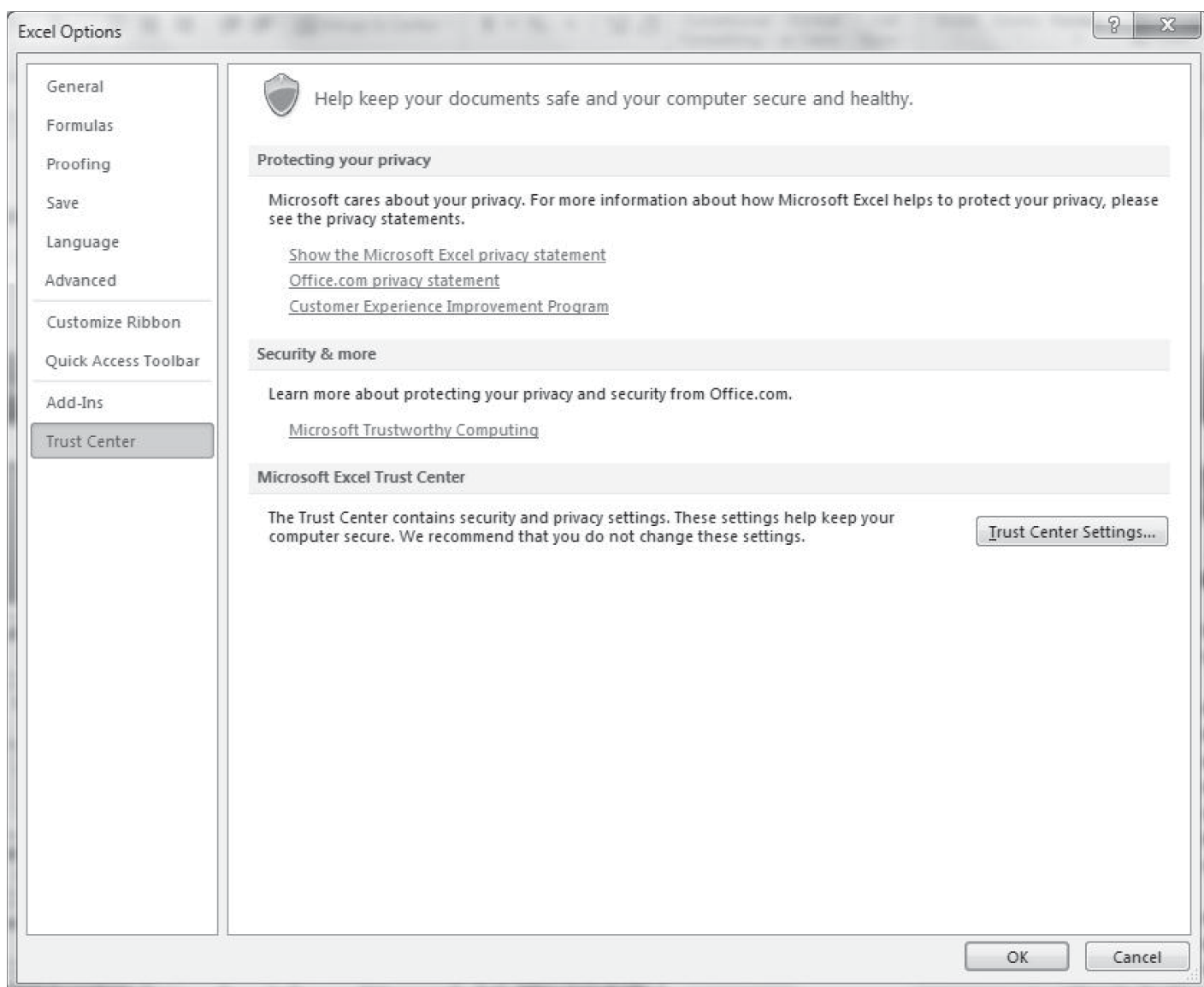
Figure 62.   Excel Options window.
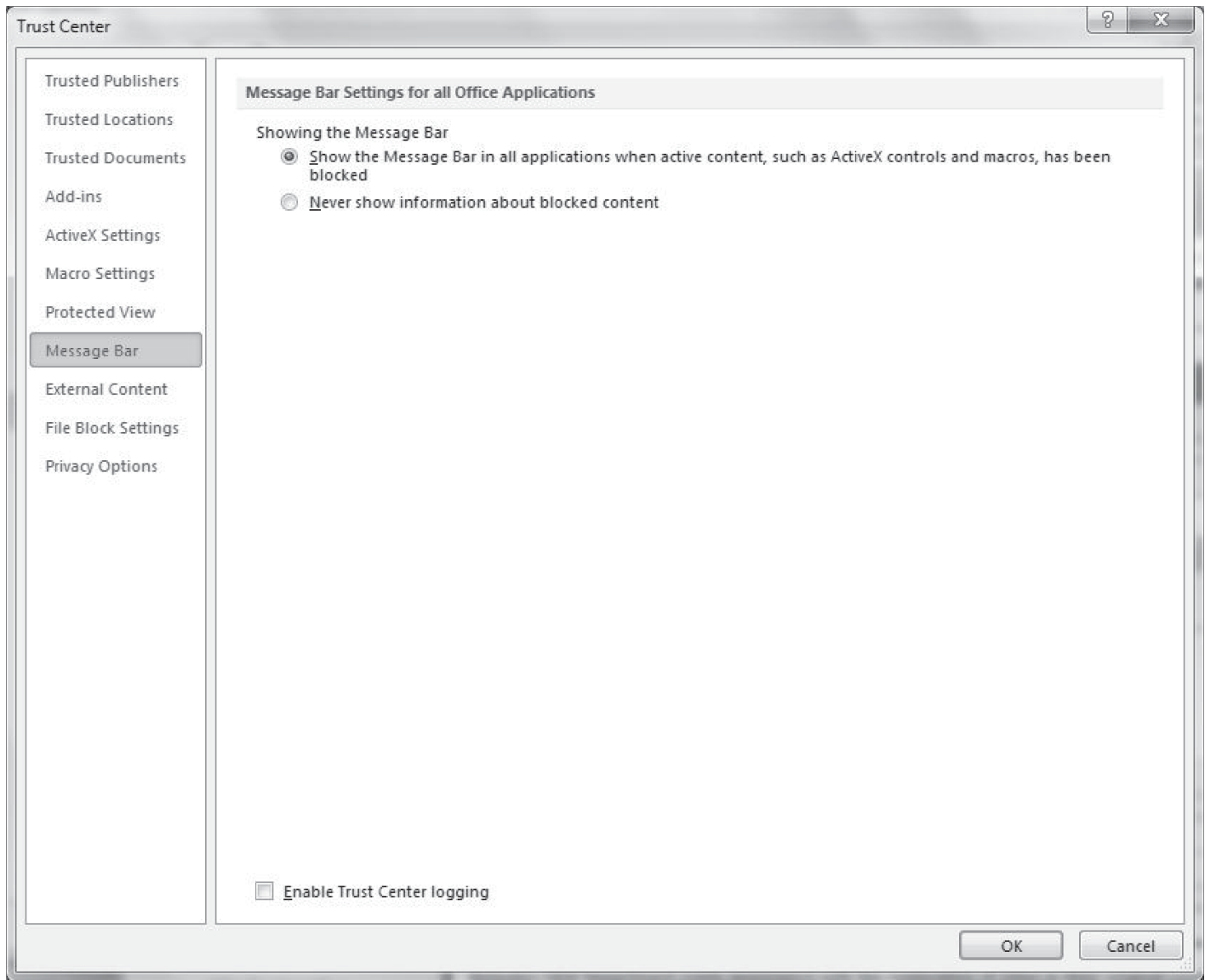
Figure 63.   *Trust Center window within MS Excel Options.*

3. Within the Message Bar section, ensure that *Show the Message Bar in all applications when active content, such as ActiveX controls and macros, has been blocked* option is selected, as shown in Figure 63.
4. Within the Macro Settings section, select the *Disable all macros with notification* option, shown in Figure 64, to return MS Excel to default settings.
5. Close the EP&CBT without saving, and reopen it.
6. The user will see the security warning shown in Figure 60. Click *Enable Content* to enable functionality within the EP&CBT.
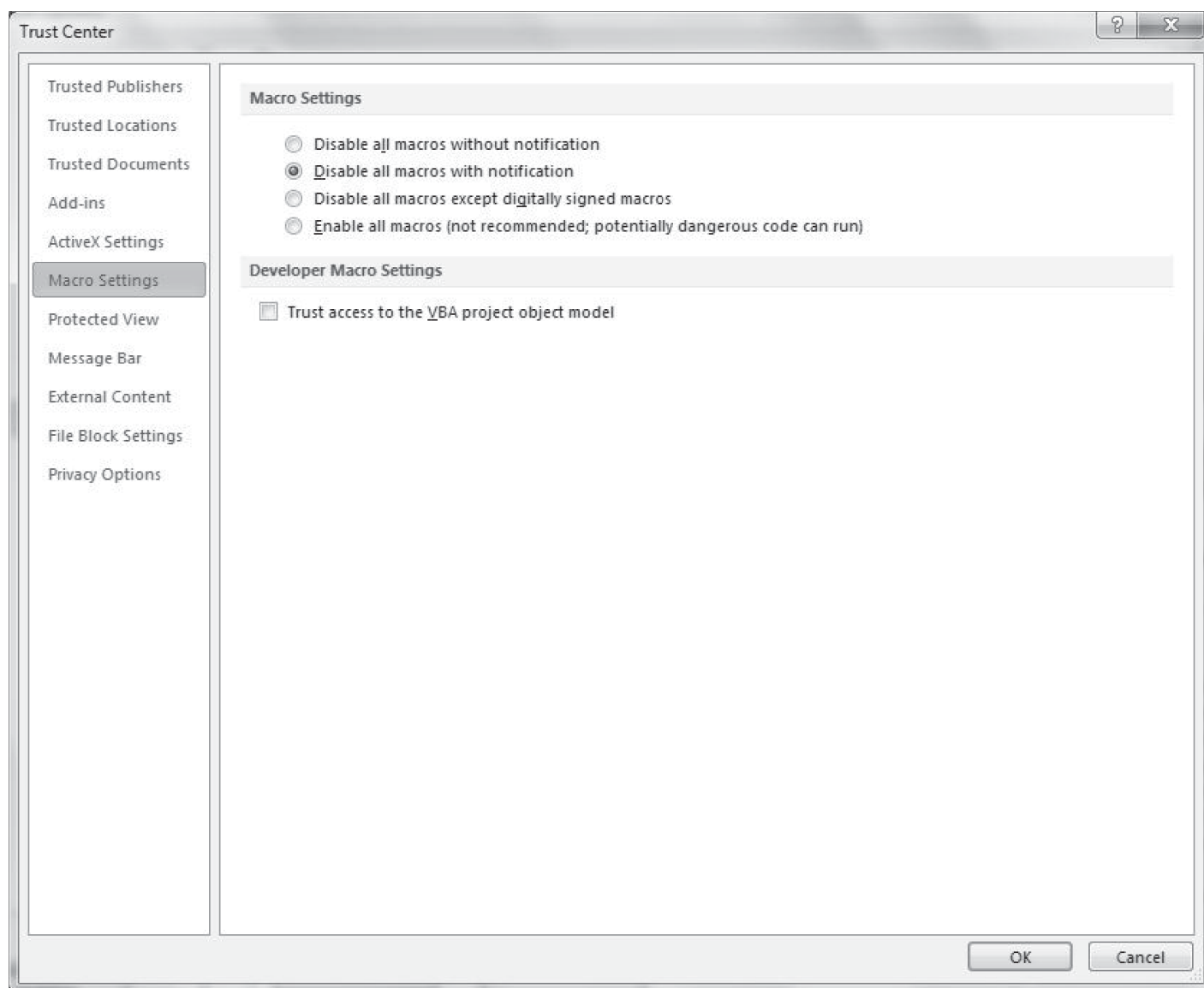
Figure 64.   Macro Settings screen of MS Excel Options > Trust Center.

2.10.2 Screen Resolution and Additional Monitors

Certain screen resolutions or the use of multiple monitors may cause the *Select Sustainability Practice Type* and *Select Airport Functional Area to be Impacted* selection boxes in the Sustainability Practice Identification section to be oversized, as shown in Figure 65, though the rest of the EP&CBT will work properly.

This is most often caused by the way MS Windows handles non-native resolutions on monitors. The monitor may be in a non-native resolution because the resolution was specifically
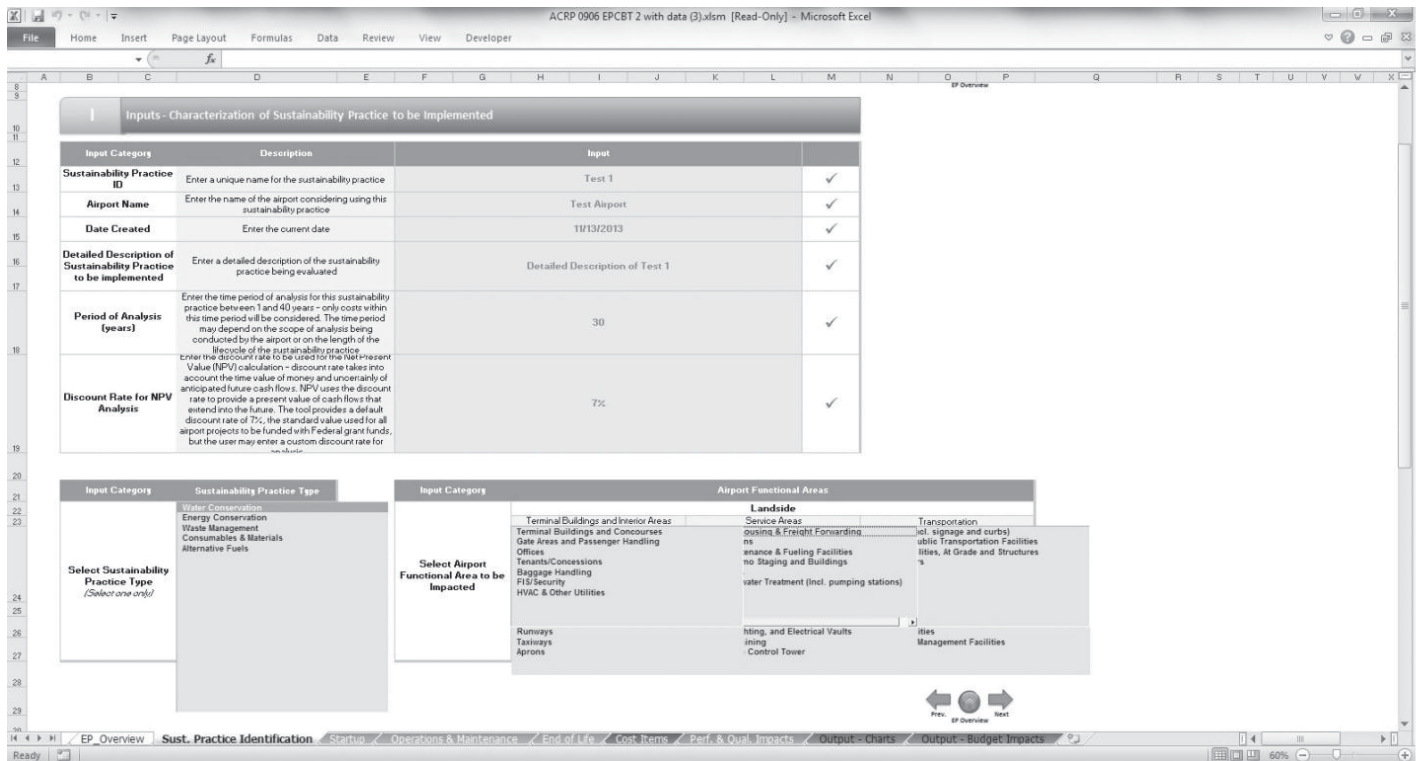
Figure 65.   Screen resolution errors.

changed. This also frequently occurs when a computer is connected to an additional monitor or display. If the additional monitor or display is of a different resolution than the computer, and the user selects to *Duplicate* the display rather than *Extend* it, the computer will be forced into the resolution of the separate display.

In MS Windows 7, changing screen resolution and adjusting the *Connect to a projector* setting can both be done from within the *Display* section of the *Control Panel*, as shown in Figure 66. The *Connect to a projector* settings are displayed in Figure 67.

2.10.3 MS Excel Has Stopped Working

MS Excel may stop working unexpectedly, producing the error shown in Figure 68. This can be caused by frequent use of the Delete function to remove cost items within the tool. When presented with this window, the user should select *Restart the program*. When MS Excel reopens, the user can reopen the last saved version of the tool and continue evaluation of the sustainability practice as normal. The user should save frequently to limit data loss if MS Excel should unexpectedly stop working.

2.10.4 Viewing Performance & Qualitative Impacts in MS Excel 2007

The conditional formatting used to graphically display the impact level of individual performance and qualitative impacts uses different graphics for MS Excel 2007. The Performance & Qualitative Impacts will still be ranked according to the impact ratings provided by the user; however, the colored bars will be displayed in a different format.
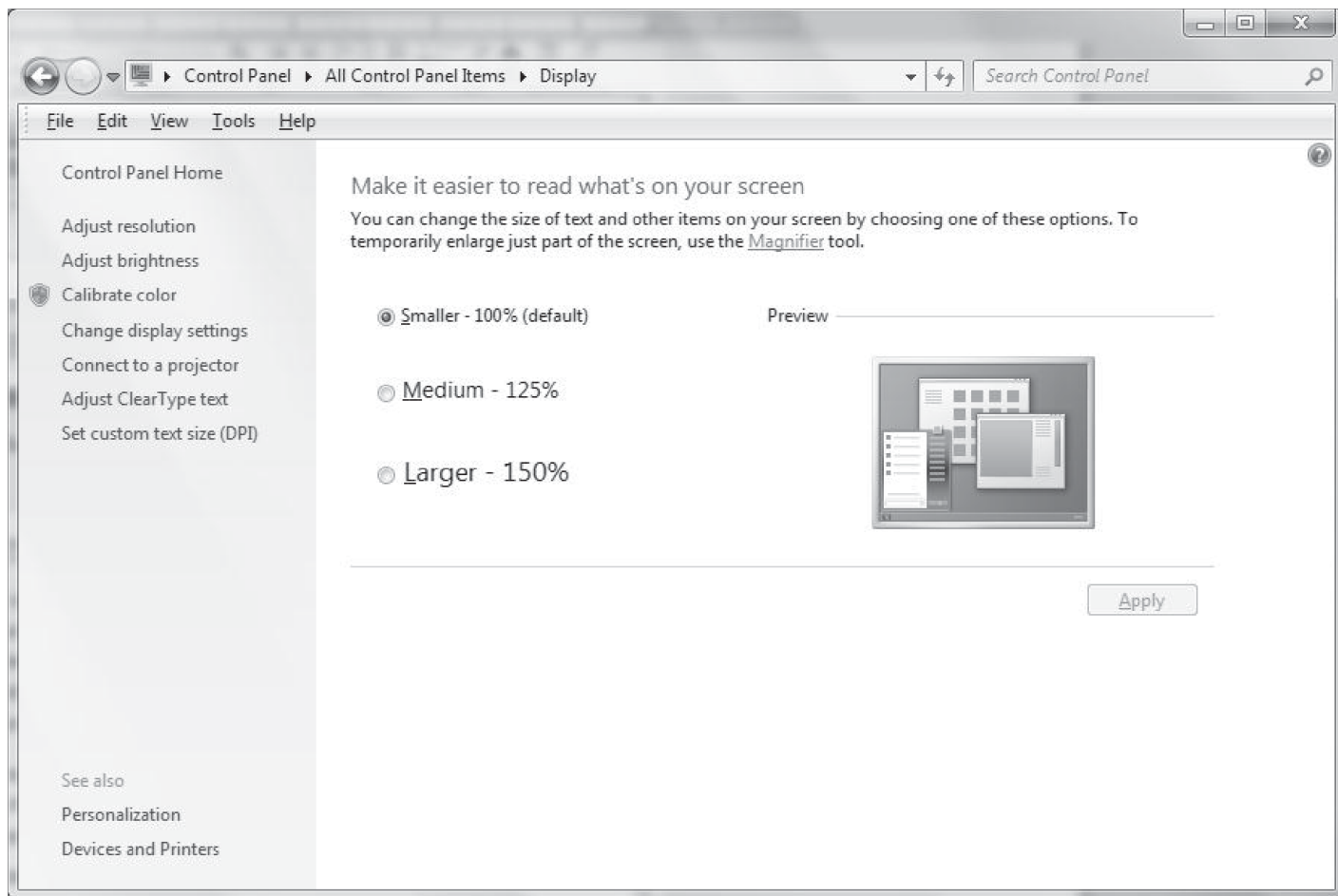
Figure 66.   Display window of Windows 7 Control Panel.
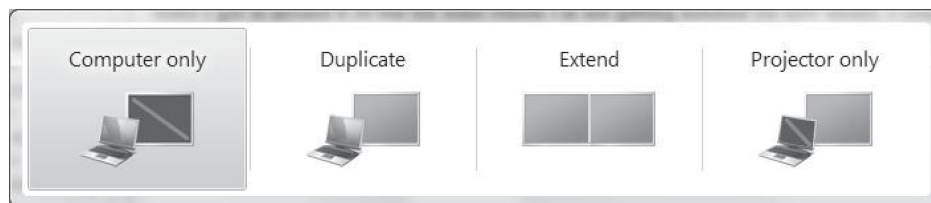
Figure 67.   Connect to a Projector settings.
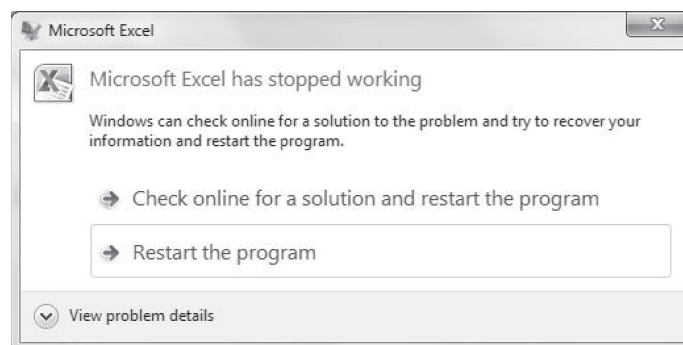
*Figure 68.   MS Excel has stopped working
error window.*

2.10.5 Using the Tool in MS Excel 2013

The EP&CBT was designed primarily to work with MS Excel 2010 and is compatible with MS Excel 2007, though it is incompatible with MS Excel 2013. The user will be unable to use the tool from within MS Excel 2013.

2.10.6 Visual Basic for Applications (VBA) Error

If the VBA editor window pops up and an error is displayed, an error has occurred while executing one of the macros that is embedded in the EP&CBT. This might occur if data are entered in a non-standard way or the tool is used in a way that it was not developed to handle. If the user can identify the action that caused the issue, the user can exit the EP&CBT, reopen the last saved version, and modify the action.

PART II

Research Report

Pre–Case Study Work

3.1 Pre–Case Study Approach

The first step of this project was to conduct initial research to determine the usability requirements and proposed outputs of the EP&CBT, a representative set of sustainability practices that the EP&CBT must be capable of evaluating, and the criteria for assessing the O&M implications of implementing sustainability practices within the tool. To this end, the project began with a literature review, brainstorming sessions with subject matter experts (SMEs), and a review of the Sustainable Aviation Guidance Alliance (SAGA) database. The project team confirmed and adjusted these initial findings during the case study portion of this project.

3.1.1 Literature Review

The project team reviewed industry and scholarly documents on airport sustainability plans and practices, operational and facility sustainability cost valuation, and airport O&M practices and challenges. Several of the documents provided insight into the types of sustainability practices that airports are implementing and associated challenges. The project team considered these practices when selecting the sustainability practices that the EP&CBT must be capable of evaluating. This information was also useful in selecting airports for participation in the case study since these airports have first-hand knowledge of how the sustainability practices have impacted their maintenance departments. Other literature helped the project team to build the framework for and test the EP&CBT. Appendix A shows the key documents that the project team reviewed and the associated findings.

3.1.2 SME Input

The project team held three structured brainstorming sessions with SMEs. The brainstorming sessions included experts in sustainability, airport O&M, and the SAGA database. Several participants were also part of the project teams for ACRP Projects 02-28 and 02-30. The brainstorming sessions were approximately an hour to an hour and a half in duration. The main focus of these sessions was to identify the user and functional requirements of the tool as well as the initial list of criteria for assessing the O&M impacts of implementing the sustainability practices within the EP&CBT.

3.1.3 SAGA Database Review

The project team used the SAGA database to assist in the selection of the initial set of sustainability practices to develop and test the tool. The project team filtered the 970 sustainability practices in the SAGA database by category, activity, and functional area (shown in Table 3) to

Table 3. SAGA sustainability database filters.

Practice	Activity	Functional Area
• Energy Efficiency and Atmosphere • Facility Operations • Ground Transportation • Indoor Environmental Quality • Landscape and Exterior Design • Materials and Resources • Water Efficiency	• Day-to-Day Airport Operations • Maintenance	• Terminal Buildings/Concourses • NAVAIDS, Lighting, and Electrical Vaults • Facilities • HVAC and Other Utilities • Stormwater Management Facilities • Water/Waste Water Treatment • Vehicle Maintenance and Fueling Facilities

identify those practices that fall within one of the five sustainability categories within the scope of this project (i.e., water conservation, energy conservation, waste management, consumables and materials, and alternative fuels) and directly relate to O&M. The application of these filters resulted in 100 sustainability practices, which the project team then further reduced to 20 by removing similar practices, selecting practices that were highlighted in the literature review, ensuring a cross section of different types of sustainability practices (e.g., equipment changes, new policies, facility changes, or practices that require special maintenance or equipment), and using additional professional judgment as necessary.

3.2 Pre–Case Study Findings

The literature review, SMEs, and SAGA database review showed that the EP&CBT must have certain characteristics to meet the needs of its intended users. The resulting user and functional requirements are presented in Table 4.

In addition, the EP&CBT must be capable of evaluating the O&M impacts of various types of sustainability practices. The cross section of practices identified from the literature review and

Table 4. User and functional requirements for the EP&CBT.

User Need	Functional Requirement
Must Be User Friendly – Airport O&M staff are busy and may not have cost analysis or accounting backgrounds. Therefore, a process or tool must be simple and possible to complete relatively quickly and easily, while also providing a practical view of the likely impacts of sustainability practices.	The tool will be usable by the "layperson" and will not require an excessive amount of time or cost to use (e.g., will not require extensive training and should take between 10 to 60 minutes per sustainability initiative).
Must Be Flexible – Airports encompass a wide range of sizes, locations, operations, and facilities, leading to differing degrees of data availability. The EP&CBT must be capable of supporting cases where there is detailed data with a high degree of accuracy (e.g., reductions or increases in energy costs, or costs of new equipment) and cases where data may not be readily available or may be qualitative with a high degree of uncertainty (e.g., additional staff time to manage new recycling practices). The tool must also be flexible given that new sustainability practices/technologies may emerge in the future and the tool must be capable of evaluating them.	The tool will support detailed quantitative data, rough order quantitative data, qualitative information, and incorporate a measure of certainty associated with the data. The tool will also support a wide range of sustainability practices.

Table 4.   (Continued).

User Need	Functional Requirement
Must Align with Other Relevant ACRP Projects – A significant investment has been made through ACRP Projects 02-28 and 02-30 to develop a "decision tool for airports to identify, evaluate, prioritize, and select sustainability practice." Therefore, it is essential that the EP&CBT is compatible with the decision tool.	The tool will incorporate a detailed understanding of other relevant ACRP projects to strengthen synergy between the tools.
Must Accommodate Different Types of Sustainability Practices – The scope of this study includes five categories of sustainability practices. Within those five categories, there are also different types, such as policy, equipment change, etc. Therefore, it is essential that the EP&CBT is capable of evaluating all types.	The tool will support a wide variety of sustainability practices.
Output Must Serve User – For a tool or process to be effective, it must produce outputs that help specific users with planning and decision making. For example, one output of a cost–benefit tool could be an estimated switching cost of $20,000. An additional output could explain that this cost is due to the need to renegotiate waste collection contracts. This additional output is especially valuable to an O&M manager as it helps in understanding the precise implications of the sustainability practice (e.g., this could require a significant amount of the manager's time).	The output of the tool will enable users to understand the O&M implications of employing sustainability practices, and use this information to make decisions about whether to implement the practices as well as the associated resources that will be needed if the practices are implemented.

the SAGA database review were used to assist in the development of the tool. Table 5 shows the 20 sustainability practices culled from the 100 practices selected from the SAGA database using the filters shown in Table 3.

Finally, the EP&CBT must include appropriate quantitative and qualitative criteria to assess the O&M impacts of sustainability practices. Table 6 shows the initial criteria developed through the pre–case study work.

The project team used these findings to begin concept development for the EP&CBT. They were then tested and improved upon in the case study portion of the project.

Table 5.   Sustainability practices selected from the SAGA database.

Project-Relevant Category	Type of Sustainability Practice	Practice	SAGA Database Category
Alternative Fuels	Equipment Change	Only use electric vehicles in indoor facilities.	Indoor Environmental Quality
	Equipment Change	Use alternatively fueled Ground Service Equipment (GSE) and shuttle buses.	Ground Transportation
Consumables and Materials	Equipment Change	Specify environmentally friendly cleaning products and processes for installed systems and products in operation and maintenance manuals.	Facility Operations
	Requires Maintenance, Special Equipment, Servicing, etc.	Require onboard recycling programs for airlines and cleaning companies, especially paper products.	Materials and Resources

(continued on next page)

Table 5.   (Continued).

Project-Relevant Category	Type of Sustainability Practice	Practice	SAGA Database Category
Energy Conservation	Equipment Change	Install automatic hand towel dispensers in restrooms.	Energy Efficiency and Atmosphere
	Equipment Change	Install efficient next-generation hand dryers instead of conventional dryers or paper towels.	Energy Efficiency and Atmosphere
	Facility Change	Use LED "exit" signs and other LED lighting in buildings.	Energy Efficiency and Atmosphere
	Facility Change	For non-buildings, including civil/stormwater and roadways/rail projects, runways and taxiways, use LED lighting and signals.	Energy Efficiency and Atmosphere
	Facility Change	Install efficient HVAC systems as HVAC consumes a large portion of energy.	Energy Efficiency and Atmosphere
	Facility Change	Install gas-fired (versus electric) kitchen equipment, such as ovens, booster heaters, and grills. Equipment should ignite electronically instead of using pilot lights.	Energy Efficiency and Atmosphere
	Facility Change	Install solar trash compactors along curbfronts and in remote areas. Solar compactors use solar energy to compact daily waste into neat 40-pound bricks.	Energy Efficiency and Atmosphere
	Facility Change	Install solar-thermal powered water heaters.	Energy Efficiency and Atmosphere
	Requires Maintenance, Special Equipment, Servicing, etc.	Install window tinting film to minimize heat and AC loss through windows, increasing energy savings. Window tinting protects carpets, drapes, and furniture from fading; cuts back on the sun's damaging UV rays; makes windows safer by preventing injury and damage from broken glass; reduces glare; and improves privacy.	Indoor Environmental Quality
	Equipment Change/ Facility Change	Install solar photovoltaic panels on buildings and/or at ground level.	Energy Efficiency and Atmosphere
Waste Management	New Policy	Increase the number of clearly marked, distinct recycling containers available in terminals.	Materials and Resources
	New Policy	Use on-site trash compactors instead of roll-offs to reduce the trips needed to remove municipal solid waste.	Materials and Resources
Water Conservation	Facility Change	Install high-efficiency irrigation systems (if irrigation is a necessity) with a slow-drip, sub-soil irrigation and automated linkages to meteorological data.	Landscape and Exterior Design
	Facility Change	Install automatic sensors on toilets, urinals, and on faucets to conserve water.	Water Efficiency
	New Policy	Recycle used non-potable water for landscaping, machine washing, urinal and toilet flushing, custodial uses, etc. to the extent allowed by the Safe Drinking Water Act of 1974.	Water Efficiency
	Facility Change	Use tank-less hot water heaters (instantaneous hot water heating).	Water Efficiency

Table 6.   Quantitative and qualitative criteria.

Type	Criteria	Metric
Quantitative	*Startup*	
	New equipment	Dollars
	Installation	Dollars
	Facility change/construction needs	Hours
	Staff training	Hours
	O&M procedure updates	Hours
	Disposal of old equipment	Dollars
	Compliance costs	Dollars
	O&M	
	Maintenance (staff time)	Hours
	Waste management	Time
	Maintain training/certification	Hours
	Compliance costs	Dollars
	Occupational safety and health	Number of Incidents
	Energy consumption	BTUs
	Water consumption	Gallons
	Material consumption	Tons
	End of Life	
	Decommissioning	Hours
	Removal	Dollars
	Disposal	Dollars
Qualitative	Impact to operational continuity	Rating Scale
	Recognition as an industry leader	Rating Scale
	Customer experience/satisfaction	Rating Scale
	Customer health	Rating Scale
	Airport community relationships	Rating Scale
	Supports strategic plan	Rating Scale

CHAPTER 4

Case Study

4.1 Case Study Approach

The cornerstone of this project was the case study, which engaged airports in the development of the EP&CBT. The project team used a three-step approach to collect data and feedback from airport stakeholders on the development of the EP&CBT (Figure 69).

In the first step, the project team gathered airport stakeholder feedback on the functional and user requirements for the EP&CBT as well as readily available quantitative and qualitative data necessary to develop and test the tool. In the second step, the project team developed a proof-of-concept for the EP&CBT (i.e., beta version). Finally, in the third step, the team engaged airport stakeholders to test the EP&CBT proof-of-concept to ensure that it precisely meets the needs of users.

4.1.1 Airport Selection Process Overview

The project team used a multi-tier process to select case study airports (Figure 70). First, the project team contacted over 600 industry representatives, primarily via email. From this initial list, the team selected 30 candidate airports. The project team conducted pre-screening telephone interviews with candidate airport representatives to select 15 case study airport participants. The 15 participant airports represented a range of airport characteristics and each has implemented sustainability practices in several of the five sustainability categories (i.e., water conservation, energy conservation, waste management, consumables and materials, and alternative fuels) with sufficient time to have generated quantitative and qualitative data on associated O&M implications. Of these 15 airports, 12 were selected to participate in the interviews as part of Step 1 of the case study and three were selected to participate as focus groups to test the EP&CBT proof-of-concept in Step 3 of the case study.

See Appendix B for more details on the case study selection process and Appendix C for the results of the pre-screening interviews.

4.1.2 Case Study Airports

Table 7 identifies the airports initially selected for interviews and for focus groups to test the EP&CBT. During the interview scheduling, the project team learned that Newton City/County Airport, Kansas, was unable to participate due to workload constraints. Based on the expansive results received from the other 11 case study interview airports, the project team moved forward with the tool development. The locations of these 11 airports are displayed on the map in Figure 71 by their airport codes listed in Table 7. In addition, during the focus group scheduling, the project team determined that Manchester–Boston Regional Airport, New Hampshire,

60
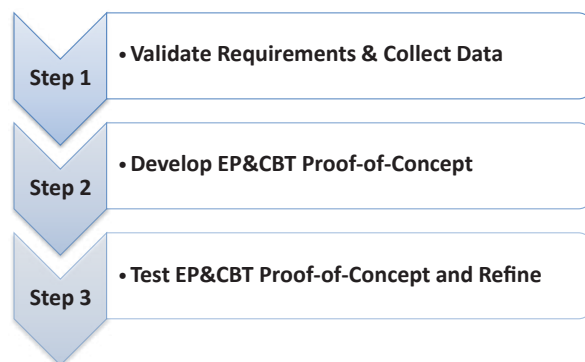
Figure 69.   Three-step case study approach.

was unable to participate; the project team substituted Fresno Yosemite International Airport, California, in order to include a small hub airport participant in the focus groups.

The following list provides summary information on the selected airports:

- **Profile:** The selected case study airports represented a range of airport characteristics and each has implemented sustainability practices in several of the five sustainability categories (i.e., water conservation, energy conservation, waste management, consumables and materials, and alternative fuels) with sufficient time to have generated quantitative and qualitative data on associated O&M implications.
- **Airport Size/Airport Staff:** The case study airports ranged in size from general aviation to large hub airports. The number of full-time equivalent (FTE) staff at each airport ranged from nearly 850 at the largest hub airports to three at the general aviation airport. Most of the case study participant airports employed between 200 and 600 FTE staff.
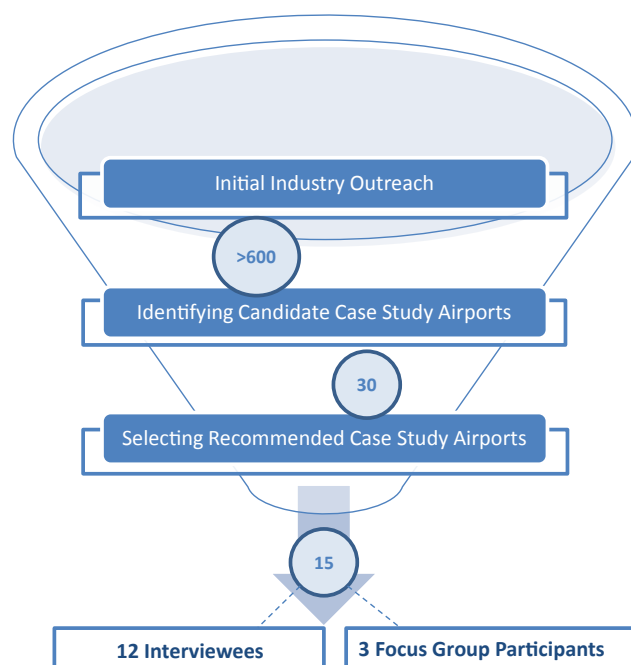
Figure 70.   Selection process for case study participants.

Table 7.   Airports initially selected for case study by participation type.

Interviews	Focus Groups
1. Phoenix Sky Harbor International Airport (PHX)—Arizona 2. El Paso International Airport (ELP)—Texas 3. Minneapolis–St. Paul International Airport (MSP)—Minnesota 4. Albuquerque International Sunport (ABQ)—New Mexico 5. Newton City/County Airport (EWK)—Kansas 6. Seattle-Tacoma International Airport (SEA)—Washington 7. Pittsburgh International Airport (PIT)—Pennsylvania 8. Outagamie County Regional Airport (ATW)—Wisconsin 9. Tucson International Airport (TUS)—Arizona 10. Lambert–St. Louis International Airport (STL)—Missouri 11. Fresno Yosemite International Airport (FAT)—California 12. Kent State University Airport (1G3)—Ohio	1. Dallas/Ft. Worth International Airport (DFW)—Texas 2. Austin–Bergstrom International Airport (AUS)—Texas 3. Manchester–Boston Regional Airport (MHT)—New Hampshire
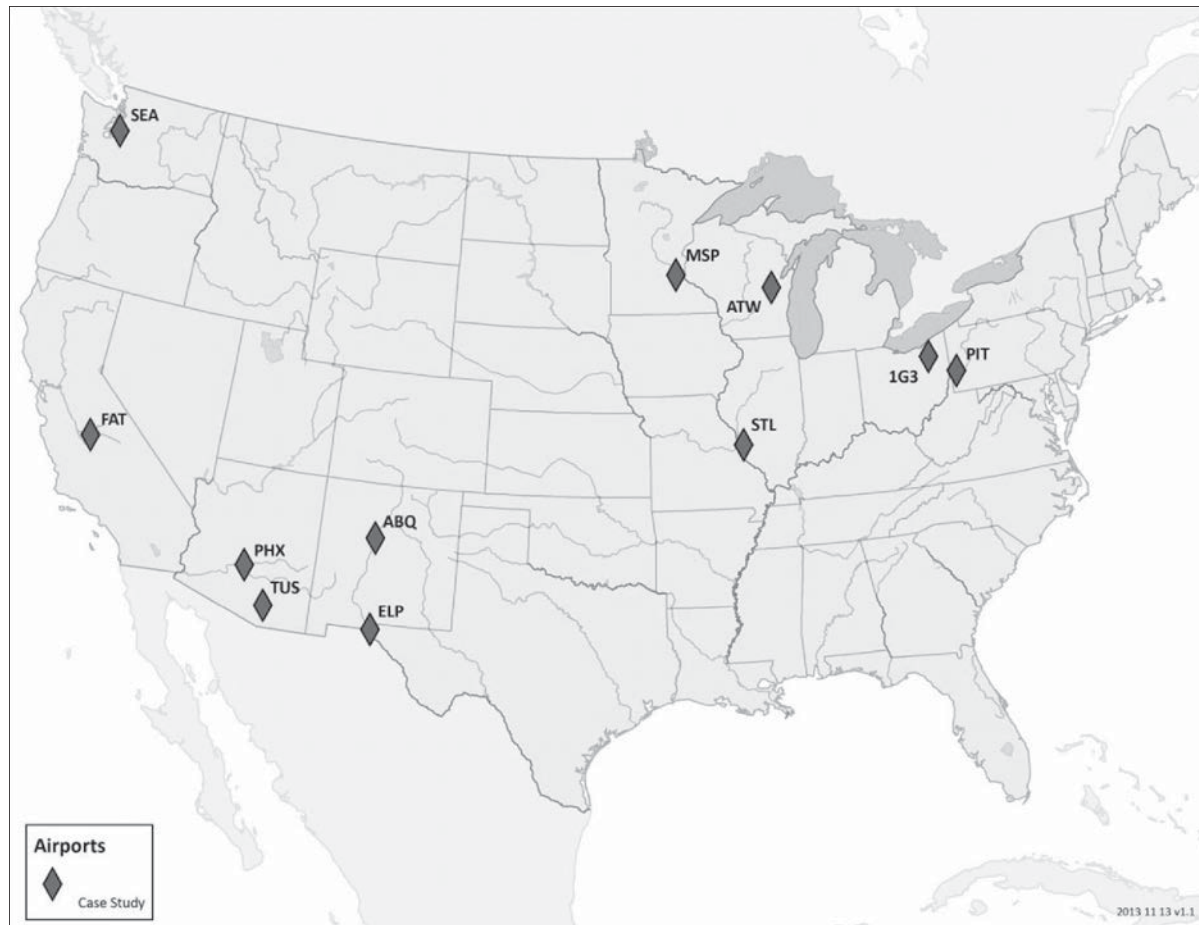
Figure 71.   Case study airports.

- **Job Functions of Case Study Participants:** The job functions of the case study participants varied from airport to airport. There was wide participation, and every interview included more than one representative from the airport. Participants ranged from the airport manager to maintenance staff. The main participants were from the airports' operations or maintenance departments, and representatives from environmental and finance departments participated in several of the interviews as well. The diversity of the participants provided unique perspectives regarding sustainability impacts on O&M operations.

4.2 Interviews

The project team conducted a series of one-on-one structured telephone interviews with 11 case study airports. These in-depth interviews focused on validating, refining, and updating user and functional requirements as well as gathering data to develop the EP&CBT proof-of-concept.

4.2.1 Interview Methodology

Interviews were held during a three-week period in April 2013. Each interview meeting was scheduled for 90 minutes. At least two representatives from the project team, including a tool developer, and several representatives from the airport, including a representative from the operations or maintenance department, participated in the interviews. The project team recorded and summarized each interview to inform the development of the EP&CBT.

The project team developed a questionnaire to guide the interview and assist participants with data collection. The project team conducted a mock interview to test the clarity of the questions and to ensure the responses elicited the information the project team was attempting to gather. The questions were then refined based on responses and feedback from the mock interview.

The project team delivered the questionnaire to each case study airport prior to the interviews to help participants understand and prepare for the topics to be discussed. Interviews followed this pre-defined, detailed questionnaire and allowed for discussion among the topics covered. Appendix D contains the interview questionnaire, which comprised the following sections:

- Project Introduction
- Contact and General Information
- Section A: Sustainability at Your Airport
- Section B: Profile of Your Facility's O&M Activities
  - O&M Budget
  - Performance
- Section C: Tool Design

4.2.2 Summary of Interview Findings

Because airports of all sizes—from general aviation to large hub—participated in these case study interviews, some findings were specific to airport size, whereas other findings were applicable to airports of all sizes. The findings are summarized in this section. The case studies detailing each airport's stakeholder responses are provided in Appendix E.

4.2.2.1 Sustainability at Airports

Seven of the case study interview airports had a formalized sustainability program/policy. All of the large and most medium hub airports had formalized programs. The four airports that did not have a formalized program or policy were the general aviation airport, non-hub, small hub, and one medium hub airport.

Regardless of whether or not an airport had a formalized sustainability program, all of the airports had implemented numerous sustainability initiatives. The initiatives most commonly implemented at the case study interview airports included the following:

- Recycling
- Water conservation
  - Low-flow fixtures
  - Landscaping
- Energy conservation
  - LED lighting
  - Solar power
  - Facility assessment
- Hybrid or electric vehicles

Several of the interviewees provided detailed cost–benefit information on these initiatives, which were used to develop and test the EP&CBT proof-of-concept.

4.2.2.2 Challenges

The most common challenge experienced by the airports was the cultural change required to implement sustainability initiatives. More than a third of the interviewees expressed encountering and overcoming this challenge.

4.2.2.3 Unexpected Outcomes

The most common unexpected outcome from implementing sustainability initiatives was the positive community support/positive press from the sustainability initiative. This was experienced by more than a third of the airports.

4.2.2.4 O&M Involvement

Of the 11 case study interview airports, 10 stated that the O&M employees assist with identifying sustainability practices, evaluating the O&M-related costs and benefits of the practices, and participating in the selection of sustainability practices. One airport did not have a formal process for implementing sustainability initiatives; therefore, O&M involvement is dependent on the project. One airport stated that the O&M department is only included in the final approval of a proposed initiative.

4.2.2.5 O&M Activities

O&M activities are conducted in the same department at more than half of the airports. Most, but not all, of the large hub airports have multiple departments performing O&M activities. With the exception of the two smallest airports, all of the airports had sub-departments within their O&M department(s). The number of employees involved in O&M activities ranged from three FTE staff to more than 600 staff.

4.2.2.6 Tracking O&M Activities

There were no clear findings regarding monitoring and tracking of O&M activities. Three airports use Microsoft Excel and two airports use a system developed in-house. The other airports utilize various professional software systems available on the market.

4.2.2.7 Training and Expertise

The airports shared that most O&M expertise is obtained through on-the-job training (nine of the airports). Of these airports, six provide self-initiated off-site training, and five provide airport-sponsored training. The remaining two airports provide specialized training as necessary.

4.2.2.8 O&M Budgeting

Average annual budgets at O&M departments vary greatly due to airport size, from $600,000 to $185 million. The clearest budget findings were among medium hub airports. Two of the medium hub airport budgets were approximately $30 million and another two were approximately $50 million. Seven of the 11 airports required projects greater than $5,000 to be capitalized. This complicates the accounting of sustainability O&M costs between operating and capital budgets at these airports.

4.2.2.9 Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, more than half of the interviewees identified the following expenses of high importance:

- Utility bills
- Equipment acquisition costs
- Fuel costs
- Contractor costs

4.2.2.10 Funding Opportunities

There was no specific interview question about funding opportunities available to the airports; however, funding was discussed. The project team found that airports are seeking ways to fund sustainability initiatives and diversify income. Funding opportunities discussed include FAA and state grants. Other income sources include land leases and non-aeronautical development.

4.2.2.11 O&M Performance

When assessing the impact of sustainability initiatives on O&M activities, more than half of the interviewees identified the following performance metrics of highest importance:

- Ensuring continuity of operations
- Managing/maintaining the budget
- Airport compliance with regulations
- Resource consumption
- Contribution to airport strategic goals (environmental stewardship, cost reduction, passenger satisfaction, and carrier relationship management)
- Customer service
- Occupational health and safety
- Cost per enplanement

When prompted, all of the interviewees indicated that the foregoing performance metrics are useful for budget planning. More than half of the airports indicated that these metrics are also useful when timing investment decisions and more than a third of the airports indicated that they are useful when planning personnel actions.

4.2.2.12 Tool Design

Five of the airports would be willing to spend four or more hours evaluating an initiative using the EP&CBT. Three of the airports stated that the time spent using the tool would depend on the complexity of the project. Four of the airports would only be able to spend a limited amount of time using the tool (less than one hour to four hours).

The most important metrics to include in the tool are as follows:

- Utility impacts
- Payback period
- Return on investment
- Lifecycle costs

The majority of the airports thought the following features would be valuable to include in the EP&CBT:

- Allow users to input actual data into the tool
- Evaluate the impacts for a group of sustainability practices
- Flag "high risk" issues
- Provide default standard cost factors

Approximately half of the airports thought the following features would also be valuable to include in the EP&CBT:

- Evaluate a custom time period
- Export to MS Excel and PDF file
- Provide summary information
- Sort/rank impacts

4.2.2.13 Airport Audience

From the interviews, the project team learned that large-sized airports typically already possess a comprehensive framework and tool suite for conducting O&M cost–benefit analysis, while smaller-sized airports typically do not have such developed capabilities. As such, the tool will primarily benefit small to medium-sized airports that do not have a fully developed O&M cost–benefit procedure and tool suite.

4.2.3 Summary of Supplemental Data

In addition to the data obtained directly via the questionnaire, the case study interview participants provided supplemental data to inform the development of the EP&CBT. A summary of the supplemental data received is provided below.

4.2.3.1 Budget

Each airport provided their annual report or a copy of the departmental budget. For most airports, this information is considered confidential and therefore cannot be detailed in this report. Additionally, most of the airports were able to provide a cost–benefit analysis for a previously implemented sustainability initiative.

The project team analyzed the budget information collected to determine the most valuable cost categories to include in the tool. The cost categories included in the EP&CBT are as follows:

- Personnel
- Materials and Supplies
- Contractual Services
- Operating Expenditures
- Capital Outlay
- Interdepartmental
- Other

4.2.3.2 Organizational Structure/Functional Areas

Each airport provided organizational charts, and several also provided functional area charts. The project team used the organizational charts to identify the organizational structure for each airport, including whether O&M activities were in one department or separate departments as well as any sub-departments. The project team leveraged these data to provide additional depth and clarity to the evaluation process.

4.2.3.3 Unanticipated Impacts

Through the interviews, the project team confirmed that not all impacts are successfully identified up front. For this reason, the project team gathered information to understand unexpected (positive or negative) outcomes as a result of implementing a sustainability initiative. While some airports provided quantitative information about unanticipated costs, many detailed qualitative experiences with customer service, press/media, and performance.

The performance and qualitative categories included in the EP&CBT proof-of-concept as a result of this information are as follows:

- Customer/Public Impact
- Employee Impact
- Impact on Airport Performance
- Other Performance & Qualitative Impacts

4.2.3.4 Work Orders

Each airport submitted example work orders to provide a better understanding of how airports monitor and track O&M activities. This reaffirmed inclusion of some cost categories in the EP&CBT, such as labor and materials. It also identified typical formats for recording O&M activities, which were leveraged in the development of the data input formats within the tool.

4.2.3.5 Other

Several airports provided existing sustainability plans and others provided detailed environmental and performance metrics. Based on the metrics identified as "most important" during the case study interviews, the project team developed the following outputs for the EP&CBT proof-of-concept:

- Cumulative Net Present Value
- Return on Investment
- Total Cost
- Baseline Cost
- Net Costs

4.3 Proof-of-Concept

The project team developed the EP&CBT proof-of-concept (beta version) in MS Excel based on the data gathered from the airport interviews and incorporated internal subject matter expertise, as well as lifecycle cost frameworks from the International Conference of Maintenance Societies (Barringer 2003) and FAA Airport Benefit-Cost Analysis Guidance (FAA 1999) that were identified in the pre–case study literature review. The proof-of-concept demonstrated the structure and functionalities of the EP&CBT and provided a concrete platform to test and evaluate the tool in order to flesh out tool requirements. It allowed the user to enter quantitative and qualitative information and display key metrics in numerical and graphical form.

4.4 Focus Groups

The project team conducted focus group testing with three case study airports—Dallas/Ft. Worth, Austin–Bergstrom, and Fresno Yosemite—in order to test the usability and effectiveness of the proof-of-concept tool, and identified potential improvements to frame the final development phase.

4.4.1 Focus Group Methodology

Based on the initial interviews, the project team determined that airports should be able to test the tool on their own in order to ensure quality feedback on usability and key requirements. Therefore, the project team conducted focus group testing in two phases for each airport.

- For each airport focus group, the project team held an initial virtual (web-based) meeting to review the background of the project and tool and to describe progress to date and the purpose of the focus group. This was followed by a tutorial of the tool using a case study of LED retrofitting at a parking garage.
- Following the initial meeting, the project team provided a working version of the proof-of-concept tool to each airport focus group to test the tool independently. Once they tested the tool (i.e., used it to enter their own case studies), the project team held a follow-up interview to debrief and collect input on tool requirements and development. Due to scheduling conflicts with one airport, a follow-up telephone/web-based interview was not held; however, the airport provided feedback through email.

4.4.2 Focus Group Findings

The airport focus groups provided insight into how the proof-of-concept tool worked for actual users; overall feedback was positive. The airports indicated that the proof-of-concept tool was useful for identifying the costs and impacts of new sustainability practices. They reported that the format of the tool forces the user to think through all possible costs and impacts without forgetting potential areas, and that methods for entering and viewing information provide benefit and are user-friendly.

The airport focus groups also identified key components of the tool that could be improved as well as current tool limitations.

The airports provided feedback for all sections of the tool. The project team compiled and consolidated the feedback to identify key development areas for the next phase of tool development. Focus group feedback fell within five main categories (which generally aligned with the sections of the tool):

- **General:** This category comprises high-level feedback about tool functionality and feedback that did not apply directly to one of the other categories. The airport focus groups reported concerns about the user's responsibility to calculate cost data, the desire for additional visibility and explanation throughout the tool, the desire to easily compare multiple sustainability practices, and comments about additional functional capability. Many of these concerns were addressed; however, some suggestions could not be implemented; for instance, automating all cost calculations for the user is not possible at this time.
- **Evaluation Process:** This category includes feedback about the evaluation process, and in general consisted of feedback that certain cost categories were overlapping or not relevant. It also included a suggestion from one airport to include cost escalation rates for different cost categories. Forecasting cost escalation rates for different cost categories is not possible at this time.
- **Cost Entry:** This category includes feedback about the cost entry process. As noted under the General category, the users asked to see additional information including definitions of categories and functionality within the tool. Some users also reported certain difficulties in entering and editing data. Several inquired if standard costs could be included in the tool. Additional information including Help screens is now provided within the tool. Due to the scenario and airport-specific nature of the costs included in this process and the large variation of those costs across airports, standard costs are not included in this tool. These could be incorporated to a greater degree in an enhanced version of this tool in the future.

- **Performance Impacts:** This category includes feedback about the Performance & Qualitative Impacts section. As with other sections, the users reported that additional information would be helpful. Users also asked for additional customization for impact categories, because many airports have their own set of core values or metrics and wanted an output representation more integrated with the cost output.
- **Output:** This category includes feedback about the output worksheets. User recommendations regarding this section were limited; however, users did indicate that the ability to analyze individual cost items was not always intuitive.

For additional details on key feedback, see Appendix F.

4.4.3 Tool Refinement

The project team created development actions from the key development areas identified through the feedback. The project team then incorporated the development actions into the proof-of-concept tool. Modifications were made throughout all components of the tool, to both underlying structure and user interface. Refinements included the following:

- Design modifications to make the tool more streamlined and intuitive, including reinforcing information and definitions throughout the tool and adding Help screens to worksheets.
- Reformulating the evaluation process to provide a comprehensive, yet clear and concise, framework for thinking through lifecycle costs.
- Updating the cost entry methodology by separating baseline and sustainability practice data, providing a clear method for editing previously entered costs, and providing enhanced flexibility in cost entry through a more comprehensive and clear framework for inputting disaggregated costs.
- Expanding the Performance & Qualitative Impacts section to enable more customizable impact categories and potentially enable entry of a level-of-importance score in addition to the level-of-impact score.
- Expanding the Outputs section to show the performance and qualitative impacts graphically next to the cost impact and provide more intuitive functionality for the individual cost analysis.

The project team further refined the tool based on ACRP project panel feedback.

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Abbreviations and Acronyms

1G3	Kent State University Airport
AAAE	American Association of Airport Executives
ABM	Airport Business Manager
ABQ	Albuquerque International Sunport
ACAA	Allegheny County Airport Authority
ACI-NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
AIP	Airport Improvement Program
ATW	Outagamie County Regional Airport
CBT	Cost–Benefit Tool
CNG	Compressed Natural Gas
e-GSE	Electric Ground Service Equipment
ELP	El Paso International Airport
EMS	Environmental Management System
EONS	Economic Viability, Operational Efficiency, Natural Resource Conservation and/or Social Responsibility
EP	Evaluation Process
EP&CBT	Evaluation Process and Cost–Benefit Tool
FAA	Federal Aviation Administration
FAT	Fresno Yosemite International Airport
FTE	Full-Time Equivalent
GHG	Greenhouse Gas
GIS	Geographic Information System
GSE	Ground Service Equipment
HVAC	Heating, Ventilation, and Air Conditioning
ICAO	International Civil Aviation Organization
IFMA	International Facility Management Association
KPI	Key Performance Indicators
KSU	Kent State University
LED	Light-Emitting Diode
MAC	Metropolitan Airports Commission
MS	Microsoft
MSP	Minneapolis–St. Paul International Airport
NAVAIDS	Navigational Aids
NPIAS	National Plan of Integrated Airport Systems
NPV	Net Present Value
O&M	Operations and Maintenance

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PANYNJ	Port Authority of New York and New Jersey
PCAir	Preconditioned Air
PHX	Phoenix Sky Harbor International Airport
PIT	Pittsburgh International Airport
QR	Quick Response
ROI	Return on Investment
SAGA	Sustainable Aviation Guidance Alliance
SEA	Seattle-Tacoma International Airport
SME	Subject Matter Expert
SMP	Sustainability Master Plan
STAR	Stewards of Tomorrow's Airport Resources
STL	Lambert–St. Louis International Airport
TAA	Tucson Airport Authority
TRB	Transportation Research Board
TSA	Transportation Security Administration
TUS	Tucson International Airport
VALE	Voluntary Airport Low Emissions Program
VBA	Visual Basic for Applications
VHB	Vanasse Hangen Brustlin, Inc.

Key Literature Review Documents and Findings

Table A-1 provides a summary of the documents reviewed as part of the case study research. Findings for each document are provided indicating how the information was used in the tool development.

The project team also reviewed several other reports that provided relevant background information. The reports included the following:

- *Sustainability Reporting Guidelines and Airport Operators Sector Supplement*, Global Reporting Initiative
- FAA Airport Benefit-Costs Analysis Guidance
- *ACRP Synthesis 35: Issues with Use of Airfield LED Light Fixtures*
- *Guide to Airport Performance Measures*, Airports Council International
- *ACRP Report 19A: Resource Guide to Airport Performance Indicators*

Table A-1.   Summary of key literature documents and findings.

Document	Link	Findings
Los Angeles World Airports Sustainability Plan April 2008	www.lawa.org	• Sustainability practices implemented at a large commercial airport that the EP&CBT must be capable of evaluating • Potential case study participant
Northeast Florida Regional Airport at St. Augustine Sustainability Management Plan	www.flynfra.com	• Sustainability practices implemented at a regional airport that the EP&CBT must be capable of evaluating • Potential case study participant
Santa Monica Airport Sustainability Plan	www.smgov.net	• Sustainability practices implemented at a general aviation airport that the EP&CBT must be capable of evaluating • Potential case study participant
FAA's Sustainable Airport Planning	www.faa.gov/airports/environmental/sustainability/	• Sustainability practices implemented at airports of varying sizes and geographic locations that the EP&CBT must be capable of evaluating • Airports participating in the pilot program could be potential case study participants
ACRP Synthesis 10: Airport Sustainability Practices	www.trb.org/main/blurbs/160369.aspx	• Sustainability practices implemented at airports of varying sizes and geographic locations that the EP&CBT must be capable of evaluating • Airports surveyed could be potential case study participants • Reasons for implementing/not implementing specific sustainability practices, which could be potential criteria for assessing O&M impacts
ICAO 9137-PART 8, "Airport Operations Services," First Edition (Printed 5/1983)	www.icao.int	• The organization of airport maintenance departments to be used in developing the framework of the EP&CBT
Sustainable Aviation Guidance Alliance (SAGA) Database	www.airportsustainability.org:8080/SAGALinks/	• Breakdown of airport functional areas to be used in developing the framework of the EP&CBT • Breakdown of sustainability practice domains to be used in developing the framework of the EP&CBT
A Life Cycle Cost Summary – International Conference of Maintenance Societies (ICOMS-2003)	www.icoms.org.au	• Lifecycle costing tree to be used in developing the framework of the EP&CBT
FAA Airport Benefit-Cost Analysis Guidance (FAA 1999)	www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/1999_FAA_Airport_Benefit_Cost_Analysis_Guidance.pdf	• Lifecycle cost model used in developing the framework of the EP&CBT
Manchester–Boston Regional Airport Parking Garage LED Lighting Retrofit	www.ledesigngroup.com/docs/case-studies/	• Details on an LED retrofit project to be used in testing the EP&CBT concept development

Case Study Selection Process

This appendix provides a detailed description of the selection of the case study airports for ACRP Project 09-06.

Initial Industry Outreach

The project team conducted an initial industry outreach to over 600 airports across the country. The project team identified airport representatives through contacts with airport industry organizations and use of industry organization membership directories and other industry rosters.

The project team enlisted industry organizations to inform their membership about the opportunity to participate in this study. Industry outreach included the following:

- *International Facility Management Association (IFMA).* IFMA submitted an email to members of the Airport Facilities Council (207 individuals*)
- *Airports Council International–North America (ACI-NA).* ACI-NA submitted an email to members of the following committees:
  – ACI-NA Small Airports Committee (278 individuals*)
  – ACI-NA Business Information Technology Committee (125 individuals*)
  ACI-NA posted a notice under the Small Airports Committee News on the ACI-NA website.

The project team submitted direct emails to more than 80 airports to enlist their participation in the study (Table B-1). The project team used the following sources to identify airports based on industry membership directories and industry rosters:

- American Association for Airport Executives (AAAE)
  – General Aviation Committee
  – Operations/Safety/Planning Committee
- ACI-NA
  – Environmental Affairs Committee
  – Technical Operations Committee
- IFMA
  – Airport Facilities Council members
- Airports participating in the Federal Aviation Administration's (FAA's) sustainability planning pilot program (http://www.faa.gov/airports/environmental/sustainability/)
- Professional reference

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* Memberships may include non-airport members (consultants, tenants, etc.).

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Table B-1. Airports directly contacted by the project team.

Abraham Lincoln Capital Airport—Illinois	Metropolitan Knoxville Airport Authority—Kentucky
Akron Canton Airport—Ohio	Metropolitan Topeka Airport Authority—Kansas
Albuquerque International Sunport—New Mexico	Metropolitan Washington Airport Authority—Virginia
Allegheny County Airport Authority—Pennsylvania	Miami International Airport—Florida
Austin–Bergstrom International Airport—Texas	Minden-Tahoe Airport—Nevada
Bangor International Airport—Maine	Mineta San José International Airport—California
Baton Rouge Metropolitan Airport—Louisiana	Monterey Regional Airport—California
Bert Mooney Airport—Montana	Newport News/Williamsburg International Airport—Virginia
Birmingham International Airport—Alabama	Newton City/County Airport—Kansas
Boston Logan International Airport—Massachusetts	Northeast Florida Regional Airport—Florida
Castle Airport—California	Northwest Arkansas Regional Airport—Arkansas
Charleston International Airport—South Carolina	Oakland International Airport—California
Chattanooga Metropolitan Airport—Tennessee	Omaha Airport Authority—Nebraska
Cincinnati/Northern KY International Airport—Kentucky	Outagamie County Regional Airport—Wisconsin
City of Brownsville/S. Padre Island International Airport—Texas	Piedmont Triad Airport Authority—North Carolina
	Pittsburgh International Airport—Pennsylvania
Cleveland Hopkins International Airport—Ohio	Porter County Municipal Airport—Indiana
Columbia Metropolitan Airport—South Carolina	Portland International Airport—Oregon
Columbus Regional Airport Authority—Ohio	Raleigh–Durham International Airport—North Carolina
Dallas/Ft. Worth International Airport—Texas	Reno-Tahoe Airport Authority—Nevada
Dallas Love Field—Texas	Renton Municipal Airport—Washington
Denver International Airport—Colorado	Sacramento County Airport System—California
Eugene Airport / Mahlon Sweet Field—Oregon	Salt Lake City International Airport—Utah
Fort Lauderdale Executive Airport—Florida	San Angelo Regional Airport—Texas
Fort Wayne–Allen County Airport Authority—Indiana	San Antonio International Airport—Texas
Fresno Yosemite International Airport—California	San Bernardino International Airport—California
Greater Rochester International Airport—New York	San Diego International Airport—California
Hartsfield–Jackson Atlanta International Airport—Georgia	Sedalia Memorial Airport—Missouri
Houston Airport System—Texas	Sioux Falls Regional Airport Authority—Iowa
Huntsville International Airport—Alabama	Smith Reynolds Airport—North Carolina
Kansas City International Airport—Missouri	Southern Illinois Airport Authority—Illinois
Kent State University Airport—Ohio	Southwest Michigan Regional Airport—Michigan
Lansing/Capital City Airport—Michigan	Spirit of St. Louis Airport—Missouri
Lee County Port Authority—Florida	Spokane International Airport—Washington
Lehigh Valley International Airport—Pennsylvania	Springfield–Branson National Airport—Missouri
Long Beach Airport—California	Tallahassee Regional Airport—Florida
Los Alamos County Municipal Airport—New Mexico	Toronto International Airport—Canada
Los Angeles World Airports—California	Trenton-Mercer Airport—New Jersey
Louisville Regional Airport Authority—Kentucky	Tucson International Airport—Arizona
Manchester–Boston Regional Airport—Massachusetts	University Park Airport—Pennsylvania
Max B. Swisher Skyhaven Airport—Missouri	Ventura County Department of Airports—California
Meacham International Airport—Texas	Waterloo Regional Airport—Iowa
Metropolitan Airports Commission—Minnesota	Wichita Mid-Continent Airport—Kansas

Candidate Airports

The project team received responses from 20 airports as a result of the initial industry outreach. The project team telephoned airports that received, but did not respond to, the emails. When selecting which airports to follow up with, the project team was cognizant to select airports that would ensure diversity in geography and airport size. From this follow-up outreach, an additional 10 airports expressed interest in participating in the study. Table B-2 identifies the 30 airports selected as candidate case study airports.

Interview and Focus Group Airports

The project team conducted pre-screening interviews to gather additional information from the 30 candidate airports in order to recommend 15 case study airport participants for the ACRP 09-06 Panel to consider. The project team considered several factors when selecting the airports to recommend, including:

- Level of Interest—Airports that responded to any of the industry outreach emails or communications were included in the 30 candidate case study airports.
- Location—Since the geographic setting affects many of the topic categories, a range of airport locations from different regions in the United States were selected.
- Airport Role—Airports serve many different roles in the National Airspace System (commercial passenger service, reliever, general aviation); as such, airports have varying abilities to fund and implement certain sustainability strategies. Case study participants needed to represent various airport roles and will aid in making this research product effective for the widest audience.
- Airport Ownership—State-owned, municipally owned, airport authority–owned, and privately owned airports may have different decision-making processes for implementing sustainability initiatives that should be considered. In addition, owners/operators of airport systems (multiple airports under the same ownership) may be able to leverage a higher economy of scale than those of single airports to implement certain initiatives. The case study participants needed to consist of a mix of multiple-airport systems and single airports for this reason.

Table B-2.   Candidate case study airports.

1. Phoenix International Airport—Arizona	15. Seattle-Tacoma International Airport—Washington
2. El Paso International Airport—Texas	16. Manchester–Boston Regional Airport—New Hampshire
3. Boise Airport / Gowen Field—Idaho	17. Pittsburgh International Airport—Pennsylvania
4. San Francisco International Airport—California	18. Dulles International Airport—Virginia
5. Minneapolis–St. Paul International Airport—Minnesota	19. Ft. Lauderdale Executive Airport—Florida
6. Port Authority of New York and New Jersey—New York / New Jersey	20. Outagamie County Regional Airport—Wisconsin
7. Albuquerque International Airport—New Mexico	21. Northeast Florida Regional Airport—Florida
8. Newton City/County Airport—Kansas	22. University Park Airport—Pennsylvania
9. Dallas/Ft. Worth International Airport—Texas	23. North Arkansas Regional Airport—Arkansas
10. San Diego International Airport—California	24. Tucson International Airport—Arizona
11. Kansas City International Airport—Missouri	25. Spirit of St. Louis Airport—Missouri
12. Boston Logan International Airport—Massachusetts	26. Austin–Bergstrom International Airport—Texas
13. Hartsfield–Jackson Atlanta International Airport—Georgia	27. Lambert–St. Louis International Airport—Missouri
14. Houston Airport System—Texas	28. Porter County Municipal Airport—Washington
	29. Fresno Yosemite International Airport—California
	30. Kent State University Airport—Ohio

- Sustainability Program Maturity—Airports with different levels of sustainability programs needed to be included because the sustainability practices implemented and the subsequent O&M implications will likely vary.
- Availability of Data—Availability of quantitative data (e.g., implementation costs, O&M costs or savings) gathered by the airport in the decision-making process and/or after implementation of the sustainability initiative was a critical factor in determining whether an airport was recommended for the case study.

The pre-screening interviews comprised eight questions used to gather classification data and information about the above factors. The full list of pre-screening interview questions and responses is included in Appendix C.

Of these 15 airports, the project team invited 12 to participate in case study interviews and three were asked to participate in focus groups to test the EP&CBT proof-of-concept. The project team selected the three focus group airport participants because they represented airports of different sizes, experience, and geographical locations.

APPENDIX C

Pre-Screening Interviews

Thirty candidate airports were contacted in order to gather more information to assist the project team in selecting 12 airports for the case study. The data from the pre-screening were used to compare airports.

Each candidate airport was asked the following pre-screening interview questions:

1. Are you willing to participate in a case study for an ACRP project? The interview would take approximately 1½ hours and materials to review are provided beforehand (2½ hours).
2. In what areas has your airport implemented sustainability activities? What are some examples of sustainability activities you've implemented in each category?
   a. Water conservation
   b. Energy conservation
   c. Waste management
   d. Consumables and materials (e.g., paper products, light bulbs)
   e. Alternative fuels
3. What quantitative and qualitative data do you currently have for O&M activities that you have implemented?
4. Which of the following do you consider when deciding which O&M activities to implement? Do you maintain data related to these impacts when implementing sustainability activities?
   a. Budgetary implications
   b. Staffing requirements
   c. Availability of appropriate metrics to monitor implementation
   d. Environmental impacts
   e. Other considerations (please specify)
5. Who is the owner/operator of the airport? (State, municipality, airport authority, or privately owned)
6. When did your airport establish its sustainability program?
7. What department manages the sustainability program?
8. Have you participated in other sustainability-related case studies in the past? If so, for what projects?

The pre-screening interview responses are included in Tables C-1 and C-2. Airports are listed in the order that they responded to the industry outreach. Two airports indicated they were unable to participate and were automatically eliminated from further consideration.

C-1

Table C-1.   Pre-screening interview responses (Part 1).

	Airport	FAA Region	Size/Role	Willing to Participate	Sustainability Activities					Metrics Available
					Water	Energy	Waste	Consum./ Mats.	Alt Fuels	
1	Phoenix Sky Harbor International Airport	Western Pacific	Large Hub	Yes	X	X	X	X	X	Waste diversion (recycling), energy, ROI, consumption (meters on cooling towers), solar analysis
2	El Paso International Airport	Southwest	Small Hub	Yes	X	X	X	X	X	Electricity, natural gas, diesel, fuel. Waste diversion as a result of the hydration station
3	Boise Air Terminal/ Gowen Field	Northwest Mountain	Small Hub	Yes	X	X	X	X		Energy, water, recycling
4	San Francisco International Airport	Western Pacific	Large Hub	Yes	X	X	X	X	X	Energy, recycling, water, CO_2 emissions, Annual Climate Action Plan
5	Minneapolis–St. Paul International Airport	Great Lakes	Large Hub	Yes	X	X	X	X	X	Waste, energy, GHG emissions, reduction of petroleum-based fuels
6	Port Authority of New York and New Jersey (PANYNJ: JFK, LGA, EWR, TEB, SWF)	Eastern	JFK (L), LGA (L), EWR (L), TEB (R), SWF (N)	Yes	X	X	X	X	X	GHG inventory, energy data, recycling data, baseline data for most airports
7	Albuquerque International Sunport	Southwest	Medium Hub	Yes	X	X	X	X	CNG on site (don't use)	PV - Money saved and KW hours; money saved for airfield lighting, recycling tonnage, GHG emissions
8	Newton City/County Airport	Central	Reliever	Yes	X	X	X	X	X	Runway materials reused, lighting will be metered to monitor energy
9	Dallas/Ft. Worth International Airport	Southwest	Large Hub	Yes	X	X	X	X	X	All utilities (electricity, natural gas, water, sewer), solar production data (produced, consumed, and provided back to grid)
10	Kansas City International Airport	Central	Medium Hub	Yes	X	X	X	X	X	None
11	Boston Logan International Airport	New England	Large Hub	Yes	X	X	X	X	X	Air quality emissions, energy, water, waste
12	Hartsfield–Jackson Atlanta International Airport	Southern	Large Hub	Yes	X	X	X			Total cost of ownership, utilities
13	Houston Airport System (Inter-continental, Hobby, Ellington)	Southwest	Inter-continental (L), Hobby (M), Ellington (R)	Yes	X		X	X	X	Cost savings on metered water for irrigation, monthly recycling savings
14	Seattle International Airport	Northwest Mountain	Large Hub	Yes	X	X	X	X	X	Computerized maintenance management system tracks both qualitative and quantitative data but it is used case-by-case for project/ activity decision making

Table C-1.   (Continued).

	Airport	FAA Region	Size/Role	Willing to Participate	Sustainability Activities					Metrics Available
					Water	Energy	Waste	Consum./ Mats.	Alt Fuels	
15	Manchester–Boston Regional Airport	New England	Small Hub	Yes		X	X	X		Data for LED lighting upgrades
16	Pittsburgh International Airport	Eastern	Pittsburgh (M), Allegheny County (R)	Yes	X	X	X	X	X	Utilities—energy (extensive), gas, water, asset management system, work order system
17	Dulles International Airport	Eastern	Large Hub	Yes	X	X	X	X		Energy usage (electricity & gas)
18	Ft. Lauderdale Executive Airport	Southern	Reliever	Yes		X	X	X		
19	Outagamie County Regional Airport	Great Lakes	Non-Hub	Yes	X	X	X	X		Monitors consumables, energy, utility
20	Northeast Florida Regional Airport	Southern	General Aviation	Most Likely	X	X	About to	X		Report card, energy, water
21	University Park Airport	Eastern	Non-Hub	Yes		X	X	X		None, but has a lighting project where it is hoping to quantify the savings
22	Northwest Arkansas Regional Airport	Southwest	Small Hub	Yes		X	X	X		Energy
23	Tucson International Airport	Western Pacific	Medium Hub	Yes	X	X	X	X		Electric
24	Spirit of St. Louis Airport	Central	Reliever	Yes	X	X	X	X		Monitors consumables (fuel, paint, glass beads)
25	Austin Bergstrom International Airport	Southwest	Medium Hub	Yes	X	X	X	X	X	Work Order Management System information, waste diversion, energy, fuel
26	Lambert–St. Louis International Airport	Central	Medium Hub	Yes	X	X	X	X	X	Utilities—energy, natural gas, water; GHG emissions; reduction of sediment in stormwater; waste diversion
27	Fresno Yosemite International Airport	Western Pacific	Small Hub	Yes	X	X	X	X		Analysis, some energy data, solar farm power
28	Kent State University Airport	Great Lakes	GA	Yes	X	X	X	X	X	Utilities, GHG emissions, regulatory compliance

L – large hub M – medium hub N – non-hub R – reliever GA – general aviation

Table C-2.   Pre-screening interview responses (Part 2).

Airport	O&M Considerations					Owner / Operator	Formal Sustainability Program?	What department manages the program?	Other case studies?
	Budget	Staff	Metrics	Enviro. Impacts	Other?				
1 Phoenix Sky Harbor International Airport	X	X	X	X	Increased productivity, impact on partners/ community, political factors	City of Phoenix	Have always had activities, but more established in the past 5–10 years	Planning & Environmental Division	Arizona State University
2 El Paso International Airport	X	X	X	X	Stocking (e.g., converting multiple fixtures to LED—fewer bulbs to stock)	City of El Paso	2009	City of El Paso Sustainability Department	No
3 Boise Air Terminal/ Gowen Field	X	X	X	X	Impact on maintenance, alternative options, lifecycle, life span	City of Boise	No formal program, but it is a formal goal	Engineering & Facilities	No
4 San Francisco International Airport	X	X	X	X	Cost–benefit analysis	City and County of San Francisco	Active for years, officially in the last 10 years	Design & Construction, Government Affairs	Yes, ACRP
5 Minneapolis–St. Paul International Airport	X	X	X	X	Cost–benefit analysis	Metropolitan Airports Commission	Active for 20+ years. Formal program approximately 5 years ago.	Environmental Affairs	No
6 Port Authority of New York and New Jersey (PANYNJ: JFK, LGA, EWR, TEB, SWF)	X	X	X	X		PANYNJ	PANYNJ - 2008 SWF - 2010 EWR & TEB - 2012	Office of Energy and Environment (PANYNJ-wide); Airports group	NYC Sea-Level Rise Task Force, Beta Test for AirportGEAR (*ACRP Report 56*), ACRP 02-28
7 Albuquerque International Sunport	X			X	Social impacts	City of Albuquerque	Early 2000s	Airport has a sustainability manager	No, but has provided its Sustainability Management System for review
8 Newton City/County Airport	X	X		X		Joint—City of Newton and Harvey County	2011	The Airport	No (However, part of FAA's Pilot Program)
9 Dallas/Ft. Worth International Airport	X	X	X	X		Cities of Ft. Worth and Dallas, independent entity with a Board of Directors	Active for 10+ years. Formal program approximately 4 years ago.	Energy, Transportation, and Asset Management	Yes, most are focused on a specific topic (waste, energy, etc.)
10 Kansas City International Airport						City of Missouri	Yes	Environmental	No
11 Boston Logan International Airport	X	X	X	X		MassPort (Port Authority)	Active for 20+ years.	Environmental	No
12 Hartsfield–Jackson Atlanta International Airport	X	X	X	X	Impacts on other internal and external entities	City of Atlanta	Formally established in 2011	Asset Management and Sustainability	

Table C-2.   (Continued).

	Airport	O&M Considerations					Owner / Operator	Formal Sustainability Program?	What department manages the program?	Other case studies?
		Budget	Staff	Metrics	Enviro. Impacts	Other?				
13	Houston Airport System (Intercontinental, Hobby, Ellington)	X	X	X	X	Long-term effects; what happens during a drought. Will it be effective in 5 years? What training will be required?	Municipality	No formal program	Airport Maintenance	No
14	Seattle International Airport	X	X	X	X	Consider the two strategic plans that guide environmental decision making (port-wide and airport-specific plans)	Port of Seattle (port authority / municipality)	Formally adopted in 2008. Many sustainability projects preceded the formal adoption.	Port of Seattle, Aviation Environmental Programs Department	*ACRP Report 80: Guidebook for Incorporating Sustainability into Traditional Airport Projects*; ACRP 02-15, "Recycling Strategies for the Airport Industry"
15	Manchester–Boston Regional Airport	X			X	ROI	City of Manchester	Sustainability Committee in 2011	All participate, lead person is in Engineering	No
16	Pittsburgh International Airport	X	X	X	X		Airport Authority	2009–2010	Maintenance	2009 GAO Airport Environmental Issues Survey; 2 ACI Surveys (2012, 2009)
17	Dulles International Airport	X	X	X	X	ROI, Public Relations / public opinion	Metropolitan Washington Airport Authority	No established program	Maintenance Engineering is taking the lead	Beta Test for AirportGEAR (*ACRP Report 56*)
18	Ft. Lauderdale Executive Airport	X	X		X		City of Ft. Lauderdale	No established program	The Airport	No
19	Outagamie County Regional Airport	X	X	X	X	Social impacts	Outagamie County		O&M	
20	Northeast Florida Regional Airport	X	X	X	X		Airport Authority	Established after the Sustainability Study		
21	University Park Airport	X	X		X	Life expectancy, safety	University owned and operated	Expect to have one after the Sustainability Master Plan	Individual units manage, Primary is the Fiscal Plan	No
22	Northwest Arkansas Regional Airport	X	X		X	Community perception, payback period	Airport Authority	Expect to have one after the Sustainability Master Plan	Administration	No (However, part of FAA's Pilot Program)
23	Tucson International Airport	X	X	X	X		Airport Authority	Yes	Planning & Development	
24	Spirit of St. Louis Airport	X	X		X		County - Enterprise Fund	No	Administration	No

(continued on next page)

Table C-2.   (Continued).

Airport	O&M Considerations					Owner / Operator	Formal Sustainability Program?	What department manages the program?	Other case studies?
	Budget	Staff	Metrics	Enviro. Impacts	Other?				
25 Austin–Bergstrom International Airport	X	X		X	How initiatives fit into the City's vision for sustainability	City of Austin	Not a formal program; has always been incorporated.	Environmental group (under Engineering)	Yes, ACRP with LeighFisher; recently contacted about a climate change ACRP project
26 Lambert–St. Louis International Airport	X	X	X	X	Social impacts, investment	Owner—City of St. Louis; Operator—Airport Authority	Informally since the 1990s, started a formalized program in 2011	The Green Team	A project with Chicago (Sustainable Airport Management Team) for the Green Airports Conference
27 Fresno Yosemite International Airport	X	X	X	X	Practicality; Evaluate initiatives based on their airport/needs	City of Fresno	Yes, several years ago	The Airport	No (However, part of FAA's Pilot Program)
28 Kent State University Airport	X	X	X	X	Wellness, future measures of success (health care costs, student retention), regulatory compliance	Kent State University	Formally established in 2008	Facilities Planning and Operations	No

Interview Questionnaire

Transportation Research Board
ACRP 09-06
Evaluating Impacts of Sustainability Practices
on Airport Operations and Maintenance

Questionnaire

This questionnaire supports the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP) 09-06 project, "Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance."

The objective of this ACRP research project is to develop an evaluation process and cost–benefit tool to evaluate the day-to-day operations and maintenance (O&M) impacts of implementing sustainability practices at airports. The tool will help airports better plan and implement more effective sustainability practices by ensuring all the benefits and costs—including day-to-day O&M impacts—are accounted for in the decision-making process.

For the purpose of this research project, "day-to-day O&M" is defined as those functions and activities performed by airport facility O&M staff that routinely keep the facilities operating and in good condition, such as maintaining buildings, grounds, utilities, pavement and equipment, operating public spaces such as terminal drives, passenger terminal lobbies and baggage claim areas, and operating non-public secured areas such as baggage handling areas, aircraft aprons, taxiways, runways and landscapes included within airport perimeter fencing.[1] A "sustainability practice" is defined as an activity that results in economic viability, operational efficiency, natural resource conservation and/or social responsibility (EONS) benefits (e.g., energy, water or natural resources conservation), even if the intended reason for implementing the practice was not primarily for any of those benefits [e.g., replacing a heating, ventilation, and air conditioning (HVAC) system with a more efficient model].

This questionnaire aims to identify day-to-day O&M activities that can be affected by sustainability practices and the processes which airports use to anticipate and evaluate these effects. The results of this questionnaire will aid in the development of the evaluation process and cost–benefit tool.

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[1] It does not include three other broad categories of management activities: (1) the longer term airport management functions such as planning, finance, accounting, information technology, lease negotiations, engineering and construction management, environmental permitting and compliance, public affairs and communication, and marketing; (2) emergency management functions such as fire, police, security, and public health and safety; and (3) the operations of tenants such as airlines, terminal and ground access concessionaires, and agencies such as the FAA and TSA.

The Project Team developed the questions below to inform the TRB ACRP 09-06 study. Please complete this questionnaire to the best of your ability in advance of our phone interview. The purpose of the phone interview will be for the Team to clarify any questions you may not have been able to answer and to obtain additional information to your written responses, as needed. When responding to the questionnaire, please adhere to the definitions provided in the introduction.

The questionnaire is broken out into the following sections:

- Contact and General Information
- Section A: Sustainability at Your Airport
- Section B: Profile of Your Facility's O&M Activities
  – O&M Budget
  – Performance
- Section C: Tool Design

Contact and General Information

- Name: Click here to enter text.
- Airport Name: Click here to enter text.
- Job Title/Department: Click here to enter text.
- Mailing Address: Click here to enter text.
- Email Address: Click here to enter text.
- Telephone Number: Click here to enter text.
- Airport Owner/Operator: Click here to enter text.
- Number of Full-Time Equivalent (FTE) Airport Staff (excluding tenants): Click here to enter text.

Section A—Sustainability at Your Airport

The following questions focus on your Airport's sustainability program and practices.

A.1 Has your airport implemented:

   a. A formal sustainability program or policy? Choose an item.
   b. If yes, how long has the sustainability program or policy been in place? Click here to enter text.
   c. If no, are sustainability practices implemented on an ad-hoc basis (recycling, low energy lighting, etc.)? Click here to enter text.

A.2 If you answered "yes" to Questions A.1.a or A.1.c:

- Who/which department(s) makes the main decisions whether to implement sustainability practices? Click here to enter text.
- How is the facility O&M staff involved in decisions about which sustainability practices to implement? *(Check those that apply)*
  ☐ The facility O&M staff is not involved
  ☐ The facility O&M staff helps identify sustainability practices
  ☐ The facility O&M staff helps evaluate the O&M-related costs and benefits of different sustainability practices
  ☐ The facility O&M staff participates in selecting which sustainability practices should be funded and implemented
  ☐ Other, please specify: Click here to enter text.

- Please list 5–10 sustainability practices that have been implemented at your airport. Click here to enter text.
  - ☐ Please provide any data that was used to evaluate the O&M-related costs and benefits, if such an analysis was performed. *(Check if data are attached).*

A.3 Have you experienced unexpected outcomes as a result of implementing a sustainability initiative? If so, please specify. Click here to enter text.

Section B—Profile of Your Facility's O&M Activities

The following questions are about the facility operations and maintenance activities at your Airport.

B.1 Your department's title(s): Click here to enter text.

B.2 Do facility operations and maintenance activities occur within the same department at your Airport? Which department(s)? Click here to enter text.

B.3 Within your airport organizational structure, where are facility operations and maintenance staff represented? (Please provide an organizational chart, if available.) Click here to enter text.

B.4 How many staff members are involved in operations and maintenance activities? Click here to enter text.

B.5 Are there any specialized sub-groups / divisions working on facility operations and maintenance activities? What are their primary skills and functions? Click here to enter text.

B.6 What is the technical training of staff working on facility operations and maintenance activities (e.g., Professional Engineers, HVAC, LEED, etc.)? Click here to enter text.

How has O&M staff expertise in sustainability been obtained (e.g., Airport-sponsored training; Self-initiated off-site training; On-the-job experience, etc.)? Click here to enter text.

B.7 What tools or technologies do you currently use to monitor O&M activities and track work orders (e.g., MS Excel, MAXIMO, etc.)? Click here to enter text.

O&M Budget

B.8 What is the average annual combined O&M budget? Click here to enter text.

B.9 Which costs are tracked in your O&M budget(s)? How important is it that these costs be evaluated when assessing the impact that a sustainability practice will have on O&M activities? *Check all that apply.*

Costs	Check those that apply	Level of importance in evaluating impact of sustainability practice on facility O&M activities (High/Medium/Low)
Equipment acquisition	☐	Choose an item.
Staff salaries	☐	Choose an item.
Training (for staff and/or tenants)	☐	Choose an item.
Utility bills	☐	Choose an item.
Contractor costs (e.g., waste disposal, equipment maintenance)	☐	Choose an item.
Fuel costs	☐	Choose an item.
Other (list):	☐	Choose an item.
Click here to enter text.	☐	Choose an item.
Click here to enter text.	☐	Choose an item.
Click here to enter text.	☐	Choose an item.
Click here to enter text.	☐	Choose an item.

B.10 Please provide a sample budget (attach separately).

B.11 What is the dollar amount that requires O&M purchases to be capitalized? Click here to enter text.

B.12 What is the process for preparing the day-to-day facility O&M budget? Click here to enter text.
- Who prepares the O&M budget(s)? Click here to enter text.
- How often are O&M budgets (and revenue forecasts, if applicable) updated? Click here to enter text.
- Who approves the O&M budget (i.e., who would approve requests for additional funding due to new requirements)? Click here to enter text.
- If a new sustainability practice is selected to be implemented at the airport:
  - How would this be incorporated into the O&M budget (e.g., a new recycling program)? Click here to enter text.
  - What information is provided to the facility O&M staff to help develop their budget/evaluate resource impacts? Click here to enter text.
    - Is the outcome of this assessment (impacts to the O&M budget) then factored into the final implementation decision? Click here to enter text.
    - If so, how? Click here to enter text.

Performance

B.13 How is the performance of the facility O&M staff measured? How important is it that these metrics be evaluated when assessing the impact a sustainability practice will have on the facility O&M staff? *Check all that apply.*

Performance Metrics	Check those that apply	Level of importance in evaluating impact of sustainability practice on facility O&M activities (High/Medium/Low)
Managing/maintaining your budget (i.e., staying within your annual budget)	☐	Choose an item.
Airport compliance with environmental regulations	☐	Choose an item.
Resource consumption (water, energy consumption, waste management costs, etc.)	☐	Choose an item.
Occupational Health and Safety (injury & illness rates, complaints, etc.)	☐	Choose an item.
Customer service (e.g., response time for spills or temperature control)	☐	Choose an item.
Ensuring continuity of operations (e.g., terminals remain functional)	☐	Choose an item.
O&M employee satisfaction/retention	☐	Choose an item.
Contribution to Airport Strategic Goals	☐	Choose an item.
▪ Passenger satisfaction	☐	Choose an item.
▪ Carrier relationship management	☐	Choose an item.
▪ Environmental stewardship	☐	Choose an item.
▪ Cost reduction	☐	Choose an item.
Other (list):	☐	Choose an item.
Click here to enter text.	☐	Choose an item.
Click here to enter text.	☐	Choose an item.
Click here to enter text.	☐	Choose an item.
Click here to enter text.	☐	Choose an item.

B.14 Does the facility O&M staff use tools to track and monitor performance? If so, please describe and provide/attach examples of outputs (e.g., BIM, spreadsheets, and reports). Click here to enter text.

B.15 What other (not already listed in B.9 and B.13) quantitative and qualitative benefits and/or costs typically influence a go/no-go decision to implement a specific practice by the facility O&M staff (e.g., staff time, union concerns)? Click here to enter text.

B.16 Does the facility O&M staff collect data on the above metrics/factors from questions B.9, B.13, and B.15? Choose an item.

   a. What are the sources of your data? Click here to enter text.

   b. If you do not have data, are you able to provide estimates? Click here to enter text.

   c. What would these estimates be based on? Click here to enter text.

B.17 When are performance metrics most useful in decision making (e.g., personnel actions, timing of investments, budget planning, union negotiations, scheduling of training programs, etc.)? Click here to enter text.

Section C—Tool Design

One product of this ACRP 09-06 research project will be a tool to evaluate the costs and benefits of implementing sustainability activities. The following questions are about the desired content and functionality of this tool.

C.1 Approximately how long would you be willing to spend evaluating the O&M impacts of a single sustainability practice (e.g., time spent entering information, reviewing results, etc.)? Choose an item.

C.2 What types of reports or metrics should be generated by the tool to help facility O&M staff influence the decision-making process (as to whether a sustainability practice should be implemented)? Click here to enter text.

C.3 What time period should be covered when looking at impacts (e.g., 1, 2, 5 years, etc.)? Click here to enter text.

C.4 Would it be useful to allow users to input actual data into the tool (e.g., utility bills) as well as knowledge-based estimates? Click here to enter text.

C.5 Would it be useful to enable users to flag "high-risk issues" (e.g., union concerns, potential operational impacts, etc.)? Click here to enter text.

C.6 Would you want to compare the results from multiple sustainability practices? Click here to enter text.

C.7 What other features would be useful? Click here to enter text.

Thank you for your time.

Detailed Interview Reports

Each of the 11 airports selected to participate in the case study activities provided information during a series of 60- to 90-minute interviews. The following are the interview reports for these 11 airports. The team used the information provided at the interviews to develop the framework of the proof-of-concept tool.

E.1 Albuquerque International Sunport

General Information

Albuquerque International Sunport (ABQ) is located in Albuquerque, New Mexico. According to the Federal Aviation Administration's (FAA) National Plan of Integrated Airport Systems (NPIAS), it is a medium hub airport. ABQ is owned and operated by the City of Albuquerque Aviation Department, with 270 full-time equivalent (FTE) employees (excluding tenants).

Sustainability at the Airport

ABQ established a sustainability program in November 2008; in 2009, it developed a Sustainability Management System Plan for both Albuquerque International Sunport and Double Eagle II, the general aviation airport also operated by the City of Albuquerque Aviation Department. Prior to the established program, the Airport was implementing initiatives on an ad-hoc basis. Examples of sustainability initiatives implemented at ABQ include:

- Solar power;
- Water harvesting;
- Planting of xeric, or drought-tolerant, plant species;
- Indoor lighting replacement with high-efficiency lighting;

- Replacement of HVAC motors and drives with more efficient systems;
- Replacement of escalator motors with more efficient equipment and speed control;
- Replacement of airfield lighting and signage with LED lighting;
- Recycled asphalt and concrete from construction;
- Waste recycling; and
- Purchase of hybrid vehicles.

Challenges

ABQ has learned that technology rapidly changes and improves. The Airport completed four solar projects and has found a significant increase in efficiency between the solar panels from the first project and those from the fourth. ABQ also completed a test of LED lighting in their parking facility and found that within eight months of the project's completion, there were fixtures 30% more economical available on the market.

Unexpected Outcomes

Each year from May through July, ABQ receives renewable energy credits—a refund from its power company for excess electricity generated by the airport—because the longer days (i.e., more daylight) result in more solar energy produced than the Airport uses. This credit of 16.5 cents per kilowatt hour of excess electricity generated by the airport was an unexpected revenue source for the Airport.

O&M Involvement

Presently, ABQ's Operations and Maintenance (O&M) staff help identify sustainability practices, evaluate the O&M-related costs and benefits of the practices, and participate in the selection of sustainability practices. Data for evaluating a proposed sustainability initiative that may be considered in the decision-making process include energy usage, design life, airline costs and/or revenue, and return on investment.

O&M Activities

The Operations and Airfield Maintenance divisions are operated independently from one another, under the Associate Director of Operations. Building Maintenance and Custodial divisions are operated under the Associate Director of Planning and Development. More than 125 staff members are involved in operations and maintenance activities.

Tracking O&M Activities

Currently, O&M activities and work orders are monitored using an in-house database. This system is dated, and ABQ plans on replacing the system within the next two years. Maximo is one of the systems under consideration.

Training and Expertise

O&M staff expertise in sustainability is learned through contractors who install a new system (where applicable), and Airport-sponsored training is also provided at the local community college. Examples include training provided to both airfield maintenance and building maintenance staff for replacement of LED light fixtures. The building maintenance staff were also trained and certified to maintain a photovoltaic system and to maintain the new HVAC equipment.

O&M Budgeting

ABQ's combined average annual O&M budget is $30 million; purchases greater than $5,000 are included in the capital budget. The budget is developed on an annual basis by finance staff in conjunction with division managers and a budget analyst from City Hall. The previous budget

versus actual costs is provided to assist with budget development, as well as current year-to-date costs. Discussions for each line item take place during the budget review. There is an emphasis on repairs and maintenance, to make sure ABQ's needs are met. Once finalized, the proposed budget is then submitted to the Mayor's office and City Council for approval. Sustainability efforts have their own line item in the budget.

Budget forecasts and revenue forecasts are completed monthly. A periodic review of each department's budget is conducted with the Finance division to look for anomalies.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, the most important expenses ABQ evaluates are:

- Staff salaries,
- Utility bills, and
- Fuel costs.

Training costs are moderately important and equipment acquisition costs are of low importance, because equipment is replaced as necessary, regardless of cost.

Funding Opportunities

ABQ has been able to take advantage of rebate programs for lighting and HVAC initiatives. The Airport received Voluntary Airport Low Emissions Program (VALE) funding for the purchase of electric and hybrid vehicles and three of its solar projects and currently has a funding application for electric ground service equipment (e-GSE) charging stations.

O&M Performance

ABQ doesn't track any key performance indicators; however, the performance metrics detailed in this section are most useful for ABQ's budget planning. When assessing the impact of sustainability initiatives on O&M activities, the most important performance metrics for ABQ to evaluate are:

- Managing/maintaining the budget;
- Cost per enplanement;
- Airport compliance with regulations;
- Resource consumption;
- Ensuring continuity of operations; and
- Contribution to airport strategic goals (passenger satisfaction, carrier relationship, environmental stewardship, and cost reduction).

These metrics are of relatively equal importance to the Airport for different reasons. For example, costs per enplanement are important because, if it exceeds $10, the airlines will have to report why (to their management). Compliance with environmental regulations is important because of grant assurances.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, ABQ would be willing to spend 4+ hours using the Evaluation Process and Cost–Benefit Tool (EP&CBT). The tool could be advanced, as many users are comfortable with Microsoft® (MS) Excel and sophisticated programs.

ABQ considers the most important metrics to include in the tool are return on investment and fuel and water consumption. When calculating costs, the tool should also calculate the decrease

in maintenance. For example, lamps were previously replaced annually; however, LEDs are only replaced once every 7–10 years, which results in a drastic savings.

Additionally, ABQ suggested the following features of the tool would be valuable:

- Evaluate a custom time period;
- Allow users to input actual data into the tool;
- Flag "high-risk" issues (e.g., union concerns, operational impacts);
- Evaluate the impacts for a group of sustainability practices; and
- Export to MS Excel or PDF.

E.2 El Paso International Airport

General Information

El Paso International Airport (ELP) is located six miles east of downtown El Paso, Texas. According to the FAA's NPIAS, it is a small hub airport. ELP is owned and operated by the City of El Paso, with more than 225 FTE employees (excluding tenants).

Sustainability at the Airport

ELP does not have a formal sustainability program or policy but will likely initiate a Master Plan with Sustainability in the future. Sustainability initiatives are implemented on an ad-hoc basis and examples include:

- Installation of solar parking lot lights,
- Use of low-energy lighting,
- Purchase of hybrid vehicles,
- Purchase of plug-in electric vehicles,
- Installation of bottle fillers on drinking fountains,
- Repurposing materials,
- Recycling,
- Installation of low-flow fixtures,
- Xeriscape (only drought-tolerant) plants, and
- Tankless water heaters.

Examples of repurposing materials include:

- Iron railing, which was reused for decorative fencing with design casts;
- Granite panels from the food court have been used outdoors, for award plaques, and as counters in the military area; and
- Runway lights have been reused as gifts and used in training classes.

Unexpected Outcomes

When the Airport installed solar parking lot lighting, ELP was surprised that it didn't get any feedback from the public (good or bad). However, there was a lightning strike that knocked out electrical lighting in all of the parking lots, and the solar lights stayed on, which reinforced its value.

The Airport replaced gasoline-powered trucks for electric. One unexpected result was a reduction in vehicle usage and increased productivity because employees no longer sat waiting in the truck. Additionally, employees now carpool more often when driving on Airport property.

O&M Involvement

ELP's O&M staff assists with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices, and participates in the selection of sustainability practices. Data for evaluating a proposed sustainability initiative that may be considered in the decision-making process include energy/utility usage, return on investment, and impact to airline fees.

O&M Activities

Operations and Maintenance activities are conducted separately, but both departments are within the Operations and Security Division, under the Assistant Director of Aviation Operations & Security. There are 90 employees involved in O&M activities.

Tracking O&M Activities

ELP uses TMA systems to track work orders and MS Excel to monitor O&M activities.

Training and Expertise

Currently, none of the Airport's sustainability initiatives have resulted in new training requirements. Staff expertise is learned through on-the-job training at ELP.

O&M Budgeting

ELP's combined average annual O&M budget is $33 million; purchases greater than $5,000 are included in the capital budget. The Airport's current budget is developed using actual costs from two years prior, the budget from the year before, and the forecasted amount for the current year. This has been ELP's 4th year with a flat budget, which helps to offset other increases (e.g., rate increases). The budget is approved by the El Paso City Council.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, ELP considers the following expenses of highest importance:

- Equipment acquisition,
- Utility bills, and
- Fuel costs.

Funding Opportunities

The Airport owns excess land, currently occupied by industrial parks. These help the Airport diversify revenue sources and provide an additional revenue stream. There are two existing industrial parks and one more available once the local economy improves.

O&M Performance

Performance metrics detailed in this section are most useful for ELP's budget planning. When assessing the impact of sustainability initiatives on O&M activities, ELP considers the following performance metrics to be most important:

- Managing/maintaining the budget;
- Airport compliance with regulations;
- Resource consumption;
- Occupational health and safety;
- Customer service;

- Ensuring continuity of operations; and
- Contribution to airport strategic goals (passenger satisfaction, carrier relationship, environmental stewardship, and cost reduction).

In addition, the Airport tracks replacement costs and frequency (labor hours). Other metrics ELP tracks and monitors include kilowatt-hours and CO_2.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, ELP would be willing to spend only a short amount of time using the EP&CBT because of staff resources.

ELP considers the most important metrics to include in the tool are utility information, payback period, return on investment, net present value, and other metrics. A worst case scenario would also be useful for budget estimates.

Additionally, ELP suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate the impacts for a group of sustainability practices;
- Include initiatives to achieve the various levels of LEED certification; and
- Allow import and export to MS Excel, with sorting features.

E.3 Fresno Yosemite International Airport

General Information

Fresno Yosemite International Airport (FAT) is located in Fresno, California. According to the FAA's NPIAS, it is a small hub airport. FAT is owned and operated by the City of Fresno, with more than 75 FTE employees (excluding tenants).

Sustainability at the Airport

FAT has had a sustainability program for 13 years. The Airport also participated in FAA's Airport Sustainability Planning Pilot Program. Examples of sustainability initiatives implemented at FAT include:

- Recycling,
- Installation of low-water-use fixtures,
- Installation of low-wattage lighting fixtures,
- Maximized use of natural light and heat,
- A solar plant,
- A common use terminal, and
- Use of environmentally safe cleaning products.

Challenges

The solar plant will be owned and maintained by another entity for 20 years, at which point it will be transferred to Airport ownership. The Airport recognizes there will be O&M impacts, which will need to be addressed prior to taking ownership.

Unexpected Outcomes

When Fresno reconstructed the concourse area in 2000, the public/employees had an adverse reaction because they felt it appeared too modern compared to the rest of the terminal. However,

people appreciated the added light and other features. The rest of the terminal was upgraded for a more cohesive experience.

The main terminal at FAT was remodeled in 2012. The renovations significantly changed the look of the terminal and included features such as large artwork replicating sequoia trees and monitors depicting solar plant reports. The Airport has received much more positive community response than expected. The traveling public has been in awe of the work and pleased that the Airport has made these changes.

Approximately 10 years ago, many of the restroom faucets and lavatories were converted to battery-powered sensors. Over time, FAT found that some of the sensors worked better than others. During the recent renovations, these devices were hardwired to replace the battery-powered systems, further reducing O&M labor hours and costs.

O&M Involvement

FAT has an open door policy that allows everyone an opportunity to provide input. O&M employees assist with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices and participate in the selection of sustainability practices. Money influences most of the Airport's decisions related to sustainability initiatives.

O&M Activities

Operations and Maintenance activities both are conducted within the Operations Division. Sub-groups include airport operations specialists, airport building maintenance technicians, electricians, and airport custodians. There are 40 employees involved in O&M activities.

Tracking O&M Activities

Currently, FAT uses an in-house work order system for airfield tasks; landside (building) tasks are tracked with daily work reports.

Training and Expertise

FAT provides technical training in a variety of ways, including Airport-sponsored training, self-initiated off-site training, and on-the-job training. Additionally, as new systems are installed, training requirements are updated and implemented.

O&M Budgeting

FAT's O&M budget for Fiscal Year 2013 was approximately $7 million; purchases greater than $15,000 are included in the capital budget. In order to develop the budget, previous years' budgets with final outcomes are used for comparison and evaluation. Once the budget has been developed, the Director of Aviation approves the budget.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, FAT considers the following expenses of highest importance:

- Equipment acquisition,
- Utility bills,
- Contractor costs, and
- Fuel costs.

To assist with budgeting, the Airport knows when the end of the useful life of a product is approaching and will start budgeting for its replacement. FAT looks ahead annually for five years, then every five years for the next 25 years.

O&M Performance

Performance metrics detailed in this section are most useful for FAT's budget planning, timing of investments, scheduling of training, and personnel actions. When assessing the impact of sustainability initiatives on O&M activities, the most important performance metrics to FAT are:

- Managing/maintaining the budget,
- Airport compliance with regulations,
- Resource consumption,
- Occupational health and safety,
- Customer service,
- Ensuring continuity of operations, and
- Contribution to airport strategic goals (environmental stewardship and cost reduction).

A key performance indicator that FAT tracks is labor hours. In addition, politics can also influence the decision of whether to implement a sustainability initiative.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, FAT would be willing to spend less than one hour using the EP&CBT. The tool should be as simple as using a timesheet and user-friendly, with dropdown menus and use of commonly used terminology, or FAT believes the tool won't be used.

FAT considers the most important metrics to include in the tool are cost and labor hours. It would also be desirable for the tool to provide a level of confidence for the output/results.

Additionally, FAT suggested the following features of the tool would be valuable:

- Evaluate a custom time period;
- Allow users to input actual data into the tool;
- Provide default standard cost factors (labor costs);
- Flag high-risk issues (e.g., union concerns, operational impacts); and
- Evaluate the impacts for a group of sustainability practices.

E.4 Kent State University Airport

General Information

Kent State University Airport (1G3) is located in Stow, Ohio, and serves as the flight training facility for Kent State University's flight program. According to the FAA's NPIAS, it is a general aviation airport. 1G3 is owned and operated by Kent State University (KSU), with three FTE employees (excluding tenants).

Sustainability at the Airport

The Airport does not have a formal sustainability program or policy. Sustainability initiatives are implemented under the University's vision. KSU is progressive with its sustainability activities. The Airport receives a lot of support from KSU; however, the Airport is a stand-alone entity and makes the final decision whether to implement an initiative. Example initiatives at the Airport include:

- Preventative runway maintenance,
- Recycling of office/industrial materials,
- Self-service terminal fueling,

- Noise abatement procedures,
- Installation of low-energy lighting,
- Aircraft Tanis/glycol heating timers,
- Improved glycol spraying equipment,
- Fuel sample handling policies,
- Public outreach activities, and
- Low-impact snow and ice control.

KSU doesn't give special consideration to the Airport when selecting sustainability initiatives for implementation. For example, the Airport delivers recycling to the campus because it is in a different county which doesn't offer recycling to the Airport. Additionally, the Airport has also developed stand-alone sustainable processes (e.g., fuel handling) without the direction or prompting from KSU.

Challenges

A challenge encountered by the Airport was a cultural resistance to sustainability initiatives (i.e., not understanding the value of sustainability).

Unexpected Outcomes

Periodically, public outreach has aligned with KSU student organization initiatives. This improved environmental awareness and consciousness at KSU and the Airport.

O&M Involvement

Since the Airport has so few employees, everyone has a role in identifying sustainability practices and evaluating the O&M-related costs and benefits. The Airport staff work with the KSU Manager of Sustainability to implement the sustainability practices. The Airport has also adopted recommendations for improvements made by students, tenants, and Airport users. The primary data used to evaluate proposed sustainability initiatives are cost–benefit analyses.

O&M Activities

The Airport is unique since it is owned by KSU; some O&M activities are performed by the Airport staff and other activities by KSU staff. Industry-specific items such as airport lighting and aircraft operational surfaces are maintained by the Airport staff. Routine maintenance such as plumbing, electrical work, parking lot maintenance, and general repairs is handled by the KSU Facilities Maintenance Office.

The Airport has three full-time airport staff and 15 part-time student staff; the KSU Facilities Maintenance Office has several hundred employees who are available to the Airport as needed.

Tracking O&M Activities

The Airport uses MS Excel and FAMIS work order software to track O&M activities. MS Excel is used for the financial aspect of O&M activities. FAMIS is used to track work orders for activities performed by the KSU Facilities Maintenance Office.

Training and Expertise

None of the Airport's sustainability initiatives have resulted in new training requirements. Staff expertise is learned through on-the-job experience at the Airport.

O&M Budgeting

The Airport's O&M average annual budget (FY 2010–2012) was approximately $670,500; purchases greater than $2,500 are included in the capital budget. The budget is prepared by

the Airport staff. In order to develop the budget, labor trends, fuel flowage trends, and student growth population projections are provided to Airport staff. Once the budget has been developed, the Departmental Director approves the budget.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, the Airport considers the following expenses to be most important:

- Equipment acquisition,
- Staff salaries,
- Utility bills, and
- Fuel costs.

The Airport has a very tight budget, which forces it to be very efficient. Price is the bottom line (e.g., equipment purchased must work in all four seasons). KSU's sustainability program doesn't have a budget; any initiatives have to be justified with a cost–benefit analysis and the money has to come from an existing budget (same for the Airport).

Funding Opportunities

The Airport is financially fully independent from KSU. One example of this relationship is exemplified by the College of Applied Engineering being an Airport tenant that pays for office space and hangar rental.

O&M Performance

Performance metrics detailed in this section are most useful for the Airport's budget planning and timing of investments. When assessing the impact of sustainability initiatives on O&M activities, the Airport considers the following performance metrics to be most important:

- Managing/maintaining the budget,
- Airport compliance with regulations,
- Resource consumption,
- Occupational health and safety,
- Customer service,
- Ensuring continuity of operations,
- O&M employee satisfaction/retention,
- Contribution to airport strategic goals (environmental stewardship), and
- Tenant relationship management.

The key performance indicators for the Airport are labor hours by staff category and fuel sale in gallons. The budget is the bottom line for the Airport, but KSU will consider other aspects (e.g., union concerns). Additionally, student involvement is another influencing aspect. The students are young, more receptive to new ideas, and will volunteer to make it easier to implement initiatives. If the students want to implement a sustainability initiative at the Airport, a lot of times they will provide the labor and the Airport will pay for the materials.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, the Airport would be willing to spend four or more hours using the EP&CBT. The tool could be advanced, as there would be few users, and they are comfortable with advanced features.

The Airport considers return on investment and regulatory compliance to be the most important information to include in the tool. It would also be useful for the tool to note whether an initiative would be compatible with Airport Improvement Program (AIP) funding requirements.

The Airport recommends that the tool should have enough variables in order for it to be scalable (i.e., works for smaller airports such as 1G3). A long-term time period would be preferred for the tool.

Additionally, the Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool, preferably through direct input from other software programs to reduce human error;
- Provide default standard cost factors (labor, transportation, capital investment, climate considerations);
- Evaluate the impacts for a group of sustainability practices;
- Flag high-risk issues (e.g., safety, operational impacts, wildlife attractants); and
- Export to PDF, with the ability to create a breakdown of information/benefits to share with tenants.

E.5 Lambert–St. Louis International Airport

General Information

Lambert–St. Louis International Airport (STL) is located 11 miles northwest of downtown St. Louis, Missouri. According to the FAA's NPIAS, it is a medium hub airport. STL is owned and operated by the City of St. Louis Airport Authority and has approximately 500 FTE employees (excluding tenants).

Sustainability at the Airport

STL's initial sustainability program was developed as part of an Environmental Management System (EMS) implemented in February 2012. The Airport's official sustainability policy was developed in May 2012 and an additional 11 sustainability polices were added. Prior to that, the Airport was implementing initiatives on an ad-hoc basis. Examples of sustainability initiatives implemented at STL include:

- Use of B-20 biodiesel fuel in diesel-powered vehicles.
- Installation of the first compressed natural gas (CNG) station in 2000; STL now has two CNG filling stations, approximately 125 bi-fuel (CNG and gasoline) vehicles, and 30 dedicated CNG vehicles in the fleet.
- Installation of four electric vehicle charging stations for public use. The Airport plans to purchase four electric vehicles this year.
- Installation of LED lighting as part of new construction and renovation projects.
- Revision of the Solid Waste Disposal and Recycling Services contract language to place emphasis on recycling, rebates, and increasing the landfill diversion rate.
- Compost collection from four restaurants with plans to expand the program this year.
- The Airport requires 50–75% of all construction waste generated to be recycled.
- The Polystyrene Policy bans the purchase of polystyrene cups by Airport departments.
- The Green Purchasing Policy outlines the Airport's requirements to purchase items that are more sustainable and includes specific guidelines for items such as:
  - Paper and office supplies,
  - Appliances and electronics,

       – Furniture and structures, and
       – Goods containing fewer toxic constituents.
- Annual inventory of greenhouse gas (GHG) emissions.

The Airport participated in the 2012 St. Louis Regional Chamber Green Business Challenge, where St. Louis area businesses compete in the forum of sustainability, and STL is participating again this year. As part of the Challenge, the Airport maintains a scorecard that is used to rate the participating organizations. The scorecard documents policies developed and successfully implemented. In 2012, the Airport received a Star Circle of Excellence Award of Merit, one of the highest awarded in the Challenge.

Challenges

Funding and manpower are the prevalent challenges for O&M departments when implementing a new initiative. Issues that arise from a sustainability initiative are brought to the Green Team to be addressed.

Occasionally there is resistance to a new initiative, as it is challenging to change the culture of an organization. The Airport has found education and training to be helpful. Education helps stakeholders to understand why an initiative is implemented, rather than simply being told to do something.

Unexpected Outcomes

The Airport launched a strategic outreach program to publicize the food composting program, which received extensive press coverage in local, national, and trade media outlets. The coverage and community interest was much more extensive than expected. Another unexpected outcome was as the funding diminished, the Airport realized biodegradable bags are significantly more expensive than regular trash bags ($10 vs. $1). STL is continuing the program, but now plans for the purchase of biodegradable bags.

STL's recycling program has resulted in both positive and negative outcomes. Increased recycling rates are the prominent positive outcome. Negative outcomes include some complaints from tenants, increased space requirement for recycling bins/dumpsters, and revised hauling logistics. Complaints were primarily focused on the location of the recycling bins. The Airport provided the rationale for the placement of the bins to address these concerns. The Airport assesses the tenant location with respect to recycling bins, but also considers the hauling frequency impacts. The recycling program requires coordination and communication with stakeholders.

O&M Involvement

The Airport has a "Green Team" that meets monthly; is composed of members from various departments, including O&M; and develops and implements sustainability policies and procedures. Green Team department representatives include the Airport Director and Deputy Director of Planning and Development, Airport Properties Manager, Assistant Director of Operations and Maintenance, Fleet Maintenance Manager, Facilities Maintenance Manager, Public Relations Manager, Environmental/Health and Safety Department Manager, and Environmental Project Manager. The Airport Director has the final decision on implementation of sustainability policies and procedures.

O&M employees assist with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices and participate in the selection of sustainability practices. Additionally, most O&M departments have weekly/monthly safety meetings, during which they provide the rationale for any new initiatives. Data for evaluating a proposed sustainability initiative that may be considered in the decision-making process include cost comparisons, labor hours, and material costs.

O&M Activities

Operations and Maintenance is combined as one department at STL. Sub-departments include Facility Maintenance Contracts, Electric Shop, Auto Shop, Building Maintenance, and Climate Control. There are approximately 200 employees involved in O&M activities.

Tracking O&M Activities

STL uses MAINSAVER software to monitor O&M activities and work orders. The Airport is also considering the use of City Works software in the future.

Training and Expertise

Specialized training is provided as necessary. For example, CNG safety training and Automotive Service Excellence testing is provided for STL's mechanics.

O&M Budgeting

The average annual O&M budget is over $52 million; typically purchases greater than $50,000 are required to be included in the capital budget. The budget is prepared annually by the head of each department, which is then approved by the Senior Deputy Director.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, STL considers the following expenses of highest importance:

- Equipment acquisition,
- Staff salaries,
- Utility bills,
- Contractor costs, and
- Fuel costs.

Public relations, impact on the St. Louis community, communications with Airport stakeholders, approval of the Airport Commissioners, and FAA and state grants are also considered when deciding whether to implement a sustainability initiative.

Funding Opportunities

FAA grant funding impacts decision making. For example, STL was able to develop its EMS program because an FAA grant was available.

O&M Performance

Performance metrics detailed in this section are most useful for STL's budget planning, timing of investments, project planning, and regulatory compliance. When assessing the impact of sustainability initiatives on O&M activities, STL considers the following performance metrics to be of highest importance:

- Managing/maintaining the budget;
- Cost per enplanement;
- Airport compliance with regulations;
- Resource consumption;
- Ensuring continuity of operations;
- Contribution to airport strategic goals (passenger satisfaction, carrier relationship management, environmental stewardship, and cost reduction); and
- Public relations.

Tracking waste/recycling and utilities (e.g., water and electric) are STL's key performance indicators. The Airport uses spreadsheet tools to track these metrics.

Tool Design

The Airport would be willing to spend four or more hours using the EP&CBT. STL would likely have approximately 10 employees using the tool, and expressed the simpler the tool is, the better.

The Airport considers the most important information to include in the tool is the payback period. It would be useful to STL to include practices that can be implemented internally such as those that offer energy/electricity savings.

Additionally, the Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate a custom time period;
- Provide default standard cost factors (labor, inflation, materials, utilities, marketing, contractor/transportation costs, and training);
- Evaluate the impacts for a group of sustainability practices;
- Flag initiatives that would require badging/access to secure areas; and
- Export to MS Access and Esri's geographic information system (GIS) software.

STL also recommended the tool note whether night shifts or holidays would be affected by implementation of sustainability initiatives.

E.6 Minneapolis–St. Paul International Airport

General Information

Minneapolis–St. Paul International Airport (MSP) is located within 10 miles of downtown Minneapolis and downtown St. Paul, Minnesota; Terminal 1 is located in St. Paul and Terminal 2 is located in Minneapolis. According to FAA's NPIAS, MSP is a large hub airport. The Airport is owned and operated by the Metropolitan Airports Commission (MAC) and has nearly 600 FTE employees (excluding tenants).

Sustainability at the Airport

MAC has a formal sustainability plan, which was adopted in 2011. The sustainability plan is currently undergoing review and may be revised. Prior to establishing a formal sustainability plan in 2011, sustainability practices were implemented on an ad-hoc basis. Examples of sustainability initiatives implemented at MSP include:

- Waste reduction through recycling and diversion of organics/food waste for composting,
- Environmentally Preferable Purchasing Program,
- Energy Conservation Program,
- Reduction of dependence on petroleum-based fuels (gasoline and diesel),
- Use of alternative energy (wind and solar),
- Water reuse and recycling,
- Reduction of water consumption, and
- Study of geothermal practices (plans for implementation in the next new building project or renovation).

Challenges

There is not a lot of resistance in the decision-making process. MAC is risk adverse; sustainability initiatives are implemented within existing (or only modified slightly) budgets, and only proven technologies are selected for implementation.

As most of MSP's projects continue to be remodels or deferred-maintenance projects, O&M issues are fairly straight forward since it is existing infrastructure. When new buildings are developed, the unknown aspects of the building's operational characteristics paired with the current O&M staffing levels become the greatest challenge to maintaining appropriate levels of service.

Unexpected Outcomes

Recent changes to the Airport's minimum return-on-investment requirements resulted in impacts to the energy program, which at times went beyond the five-year standard analysis. The energy program is in a research and development phase for testing alternative energy technologies, and understanding whether larger-scale utilization at MSP would be warranted. An example research testing at the Airport was a solar/thermal project for hot water and in-floor heating. MSP conducted a small-scale project (approximately 160 panels over 1/2 acre) to determine if the project was worth expanding to the rest of the Airport.

O&M Involvement

O&M employees assist with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices and participate in the selection of sustainability practices. Additionally, MAC's Stewards of Tomorrow's Airport Resources (STAR) Team working group includes representatives from all departments of MAC, including O&M. As new targets and goals are established, the STAR Team ensures compliance. Data for evaluating a proposed sustainability initiative that may be considered in the decision-making process depends on the project, but may include lifespan, building standards, return on investment, and cost–benefit analyses.

O&M Activities

O&M activities are conducted within three divisions at MSP: Airside O&M, Facilities/Operations, and Landside Operations. Most O&M activities occur within the Field Maintenance, Facilities, and Trades departments. Nearly 200 employees are involved in O&M activities at MSP.

Tracking O&M Activities

MSP uses EnterpriseOne software to monitor O&M activities and work orders.

Training and Expertise

Typically, MSP does not provide training beyond basic self-initiated off-site training and on-the-job experience. However, when necessary, manufacturers provide technical training to MSP employees.

O&M Budgeting

MSP's average annual combined O&M budget is $185 million; purchases greater than $5,000 are included in the capital budget. The budget is prepared annually by each department head and approved by MAC. The target budget and allowable increases are provided to assist with development of the budget. New sustainability initiatives incorporated into the O&M budget need to be justified.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, MSP considers the expenses of highest importance to be:

- Equipment acquisition,
- Inventory,
- Utility bills,
- Contractor costs,
- Fuel costs, and
- Asset inventory tracking.

O&M Performance

Performance metrics detailed in this section are most useful for MSP's budget planning and personnel actions. When assessing the impact of sustainability initiatives on O&M activities, the Airport considers the performance metrics of highest importance to be:

- Managing/maintaining the budget;
- Cost per enplanement;
- Airport compliance with regulations;
- Resource consumption;
- Customer service;
- Ensuring continuity of operations; and
- Contribution to airport strategic goals (passenger satisfaction, carrier relationship management, environmental stewardship, and cost reduction/return on investment).

Safety, deliverables, and customer service are also considered when determining whether to implement an initiative. When a project budget is in development, the department's goals (e.g., holistic design) are considered. During the design process, there is a focus on these goals.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, the amount of time the Airport would be willing to spend using the EP&CBT depends on the scope of the initiative(s) assessed. MSP's usage would depend on the scope of the project and staff involvement. The tool is needed early in the design phase to be a part of good design.

The Airport considers the most important information to include in the tool is the lifecycle and length of ownership. MSP has a lot of deferred maintenance; some buildings have 50–100 years, which creates a very different lifecycle. MSP would find it useful if the tool provided examples of initiatives required by law (e.g., environmental regulations, OSHA, stormwater regulations and sampling).

Additionally, the Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate a custom time period;
- Provide default standard cost factors (labor, utilities, regional cost differences);
- Evaluate the impacts for a group of sustainability practices;
- Flag high-risk issues (e.g., important information and regulatory challenges);
- Provide the ability to sort impacts;
- Provide summary information; and
- Export to MS Excel and PDF.

MSP would like the ability to share the results of the tool and follow-up information after initiatives/programs are implemented. This information sharing would likely provide a lot of value to other participating airports.

E.7 Outagamie County Regional Airport

General Information

Outagamie County Regional Airport (ATW) is located in Appleton, Wisconsin. According to the FAA's NPIAS, it is a non-hub airport. ATW is owned and operated by Outagamie County and has 21 FTE employees (excluding tenants).

Sustainability at the Airport

ATW does not have a formal sustainability program or policy. However, the Airport participated in the FAA's sustainability pilot program and completed a Sustainability Master Plan (SMP) in 2012. The SMP included goals, initiatives, and a mission/vision statement. Sustainability initiatives are implemented on an ad-hoc basis and include:

- Construction of a net zero general aviation terminal;
- Installation of passenger terminal solar photovoltaic array;
- Installation of passenger terminal solar thermal panels;
- Passenger boarding bridge ground power and preconditioned air unit;
- Construction of a glycol storage facility;
- Pavement project best management practices;
- Recycling;
- Installation of low-flow fixtures throughout the airport terminal: faucets, urinals, and toilets;
- Installation of bio-filter off parking lot and commercial apron;
- Installation of aerated bio-filter to serve commercial apron; and
- A facilities assessment to improve equipment and lighting schedules, lighting upgrades, and occupancy sensors.

Challenges

In 2008, ATW hired a firm to conduct a facility assessment for retro-commissioning. One recommendation from the assessment was to turn off the heaters in the boarding bridges, which would save approximately $16,000 per year. This was discussed with airlines and the Airport removed some of the heaters. Afterwards, ATW received negative feedback from the airlines and had to replace some of the heaters.

Unexpected Outcomes

The Airport has experienced very positive support from the local community. In 2007/2008, ATW installed bio-filters in the short- and long-term parking lots. As they removed the suspended solids, the bio-filters got clogged up. The sand mixture had compressed and wasn't working and the Airport had to replace several of the bio-filters.

O&M Involvement

O&M employees assist with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices. This is a very successful approach for ATW as anyone can recommend initiatives. Recently, employees went through a lean program, which related to the SMP. This enabled employees to look at the regular processes and identify initiatives for

improvement. Data for evaluating a proposed sustainability initiative that may be considered include cost–benefit analyses detailing annual costs, utility savings, and payback period.

O&M Activities

Operations and Maintenance is combined as one department at ATW, with no sub-departments. There are approximately 10 employees involved in O&M activities.

Tracking O&M Activities

ATW uses MS Excel to monitor O&M activities and work orders. ATW also uses Delta Controls ORCAview to monitor HVAC performance, eGauge software to monitor photovoltaic output, and Lithonia lighting software to schedule lighting activities.

Training and Expertise

O&M staff expertise is mostly obtained through on-the-job training at ATW.

O&M Budgeting

The average annual combined O&M budget is approximately $1.4 million; purchases greater than $5,000 are included in the capital budget. To prepare the budget, ATW's Finance department compares the prior year's budget to the actual budget to see how realistic it was. Then the Finance department considers the upcoming changes for the year. The budget is submitted to the O&M Manager to update; previous utility bills and budgets are provided to assist the O&M Manager. Once the budget is developed, the Airport Director approves it, then the County Executive, next it goes to the Property and Airport Committee for approval, then the Finance Committee, and lastly to the County Board for final approval.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, ATW considers the expenses of most importance to be:

- Equipment acquisition,
- Utility bills, and
- Contractor costs.

O&M Performance

Performance metrics detailed in this section are most useful for ATW's budget planning, timing of investments, and personnel actions. When assessing the impact of sustainability initiatives on O&M activities, the Airport considers the performance metrics of highest importance to be:

- Managing/maintaining the budget;
- Resource consumption;
- Ensuring continuity of operations; and
- Contribution to airport strategic goals (passenger satisfaction, carrier relationship management, environmental stewardship, and cost reduction).

ATW also considers staff time when determining whether to implement an initiative. Additionally, the Airport has to present initiatives to the County Board. ATW builds a case, usually with a financial benefit. Many initiatives have a financial benefit; but, if it doesn't, the Airport builds a case around the social (or other) aspect. Outagamie County and Fox Valley are extremely supportive of the Airport's initiatives.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, the Airport would be willing to spend one to two hours using the EP&CBT. ATW would likely have approximately four employees using the tool, which could be advanced.

The Airport considers the most important data to include in the tool to be energy savings, cost–benefit analysis, payback period, resource conservation, and social impacts. It would be useful to ATW to include maintenance and replacement cost comparisons.

Additionally, the Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate a custom time period;
- Provide default standard cost factors (labor, cost per kilowatt hour, and cost per therm);
- Evaluate the impacts for a group of sustainability practices;
- Flag high-risk issues (but do not quantify the risk);
- Sort/rank impacts;
- Provide summary information; and
- Export to MS Excel or PDF.

E.8 Phoenix Sky Harbor International Airport

General Information

Phoenix Sky Harbor International Airport (PHX) is located three miles from the central business district of Phoenix, Arizona. According to FAA's NPIAS, PHX is a large hub airport. The Airport is owned and operated by the City of Phoenix and has approximately 850 FTE employees (excluding tenants).

Sustainability at the Airport

PHX implemented a formal sustainability policy in 2009 and is currently conducting a Sustainability Management Plan. Prior to that, the Airport was implementing initiatives on an ad-hoc basis. Examples of sustainability initiatives implemented at PHX include:

- Recycling program,
- Alternative fuel program,
- Use of solar power,
- Energy conservation through building controls,
- Lighting control program,
- Installation of LED retrofits,
- Implementation of water conservation measures including xeriscape and irrigation controls,
- Reuse of demolished pavement materials and green waste, and
- Use of LEED and the Airport's Green Guide for Design and Construction.

Challenges

The early stages of the alternative fuel program included a CNG program and PHX experienced significant difficulty with the kits to convert fleet vehicles to CNG. The CNG retrofit kits leaked and the air quality impacts were higher than factory CNG vehicles because the fittings were not tight enough. Retrofitting vehicles also voided the warranty. The newer generations of retrofit kits are better. Additionally, the rental car companies prefer clean diesel to CNG.

Unexpected Outcomes

The Airport has received positive press for several initiatives, which is always a welcomed surprise. PHX expects to have unanticipated impacts and handles the issues as they arise. For example, PHX wanted to use a non-toxic treatment for the water chiller. When the chiller is taken out of service in the winter, the Airport found that chemicals would build up. Throughout the winter, the Airport now runs water through the chillers occasionally.

O&M Involvement

O&M employees assist with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices and participate in the selection of sustainability practices. Data for evaluating a proposed sustainability initiative that may be considered include cost–benefit analyses and utility costs or savings.

O&M Activities

The majority of O&M activities at PHX occur within the Facilities and Services department. Subdivisions include Planning, Building Services, Grounds Maintenance, and Systems Maintenance. Additionally, there is a subgroup of energy technicians that work on building automation system controls. PHX is also hiring an energy engineer that will focus on sustainability initiatives. Approximately 400 employees are involved in O&M activities at PHX.

Tracking O&M Activities

PHX uses SAP Plant Maintenance for tracking work orders as well as internally developed software that interfaces with SAP called x-Port and Field-Port. For energy controls, the Airport uses Honeywell Energy Manager/Eaton.

Training and Expertise

PHX provides Airport-sponsored training, self-initiated off-site training, and on-the-job training. Technical training/certification of staff, as applicable, includes LEED certification, Certified Energy Manager, Green Guide in-service training, lifecycle cost analysis training, and commissioning training.

O&M Budgeting

PHX's average annual combined O&M budget is $85 million; purchases greater than $5,000 are included in the capital budget. The budget is prepared by the budget liaison and section managers. The budget is reviewed annually to right-size the budget and to develop the next year's base budget. Each fall, every department submits an estimate of the costs associated with providing their current levels of service with existing staffing levels for the remainder of the year and for the following year (base request). The department submissions are prepared in a two-step process: first is a review of the full-time salary and benefits; next is preparation of line item estimates for other types of expenditures. This process is also referred to as the 3+9 technical review because departments are provided with three months of actual expenditures from which to base their estimated costs for the remaining nine months of the current year and all 12 months of the following year. After an internal review process, the City Council approves the budget.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, PHX considers the following expenses to be important:

- Equipment acquisition,
- Utility bills,

- Contractor costs,
- Staff salaries,
- Training,
- Fuel costs, and
- Rebates/incentives.

The level of importance depends on the context. Cost/savings (e.g., return on investment) is typically the most frequently important consideration at PHX. If a practice is cost-neutral, then "being green" is the important factor.

Funding Opportunities

PHX can submit a supplemental request form to the City Council for additional funding. The supplemental request form requires the following information: project information/description; request justification; and itemized budget information (personnel services, contract services costs, commodities costs, and equipment costs). Other relevant information from any vendor/contractor is also necessary.

O&M Performance

Performance metrics detailed in this section are most useful for PHX's budget planning, timing of investments, personnel actions, and scheduling of training programs. When assessing the impact of sustainability initiatives on O&M activities, the Airport considers the performance metrics of highest importance to be:

- Managing/maintaining the budget;
- Cost per enplanement;
- Airport compliance with regulations;
- Occupational health and safety;
- Customer service;
- Ensuring continuity of operations;
- O&M employee satisfaction/retention; and
- Contribution to airport strategic goals (passenger satisfaction, carrier relationship management, and environmental stewardship).

In addition to the metrics above, staff resources to implement initiatives influence decision making, e.g., is the staff available, do they have the appropriate skill set/training. Local politics can also influence implementation of initiatives. PHX is considered a department in the city. Occasionally practices are implemented because the City of Phoenix requests it, even if it's not in the Airport's budget.

PHX recently acquired software to track and monitor performance. This software will track building automation, sub-meters and other loads, and water consumption. Next year the Airport plans to develop a dashboard for tracking and measuring goals.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, the amount of time PHX would be willing to spend using the EP&CBT depends on the proposed initiative(s).

For PHX, the most important metrics to include in the tool are return on investment, net present value, lifecycle cost, and budget impact. PHX noted that airlines have a very different approach/perspective than airports. For airlines, 30 days is considered long-term planning, which should be considered when selecting initiatives.

The Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate a custom time period;
- Provide default standard cost factors [labor rates, cost of living (based on region) and inflation, cost of money];
- Evaluate the impacts for a group of sustainability practices;
- Flag high-risk issues (if an initiative impacts FAA, Transportation Security Administration, Customs and Border Protection, and/or Airline Partners);
- Customize reports; and
- Provide database functionality.

E.9 Pittsburgh International Airport

General Information

Pittsburgh International Airport (PIT) is located approximately 20 miles west of downtown Pittsburgh, Pennsylvania. According to FAA's NPIAS, PIT is a medium hub airport. The Airport is owned and operated by the Allegheny County Airport Authority (ACAA) and has nearly 450 FTE employees (excluding tenants).

Sustainability at the Airport

PIT has had a formal sustainability program for approximately seven years. PIT has been implementing sustainability initiatives for many years, building on the program by adding practices with the new terminal. Once the Airport lost a significant amount of air carrier service, they implemented energy initiatives to save money. Examples of sustainability initiatives implemented at PIT include:

- Completion of an energy efficiency project on the terminal buildings (energy-efficient lighting, occupancy sensors, HVAC changes);
- Installation of high-speed overhead doors to maintain the temperature in the drive-thru areas;
- Installation of LED lighting in parking lots and the parking garage;
- New energy-efficient white roofs on all terminal buildings;
- Utility conservation using building automation system controls to turn off or minimize use of HVAC system and lighting during non-peak times;
- Installation of power conditioners on all escalators;
- Reduction of the time-outs on all baggage system conveyors;
- Construction of dedicated deicing pads;
- In the process of designing a Deicing Stormwater Treatment Plant facility;
- Green-cleaning program;
- Recycling program (pallets, grease, oil, anti-freeze, sludge, cardboard, scrap steel, tin, aluminum, batteries, and comingled recycling inside the terminal buildings) and reuse of concrete and asphalt;
- Utilization of local vendors, suppliers, consultants, and contractors when possible; and
- Flexible work schedules (10-hour workdays or other alternative schedules) to reduce the number of vehicles on the road.

Challenges

PIT has experienced some resistance to sustainability initiatives; it has required a cultural change at the Airport. For example, new light sensors were installed that turned lights off after

a period of inactivity or adjusted for daylight. Employees were used to having lights on all the time in their office and had to adapt to the new lighting. The most important thing learned from recent changes was the importance of communicating with tenants and staff to make sure people know the reason for change(s) and what these initiatives achieve.

Unexpected Outcomes

PIT has experienced unexpected outcomes at different times. Several years ago the Airport decided to try alternative fuel vehicles. The first attempt was purchasing electric vehicles for the Airline Services Maintenance staff. PIT found that these vehicles did not hold up well; for example, the vehicles tended to stop running during very cold days, which impacted the response to O&M issues. Although fuel costs were reduced, maintenance cost greatly increased. These vehicles are now either out of service or are utilized minimally.

O&M Involvement

O&M employees assist with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices and participate in the selection of sustainability practices. Although final decisions are made by a joint committee made up of representatives from all Airport departments, the committee is managed by two representatives: one from Maintenance and one from Engineering/Construction. Data for evaluating a proposed sustainability initiative that may be considered include energy consumption, payback period, and safety considerations.

O&M Activities

The Maintenance department at PIT is made up of three divisions including Facilities Maintenance, Field Maintenance, and Airline Services; there is also an Engineering/Construction department. There are approximately 275 full-time staff members in the three maintenance divisions, as well as 10 to 12 temporary employees that typically work in Field Maintenance during the winter months at PIT.

Tracking O&M Activities

PIT tracks work orders through a JD Edwards management system. The Airport also uses MS Excel spreadsheets within its asset management system and tracks project status with MS Project. For more detailed tracking during capital projects, PIT utilizes the software preferred by the Construction Manager.

Training and Expertise

O&M staff became more proficient in sustainable practices through the establishment of a culture of sustainability at PIT. The Airport encourages participation in monthly sustainability committee meetings. Participation is sought from every department, and PIT encourages each person to take back what is discussed at the group meeting to their individual subcommittees within their specific department. The Airport also encourages participation in sustainability conferences in the airline industry, as well as facilities maintenance conferences that may focus on sustainability. The Airport understands that what they are doing today is never good enough. PIT always strives to be better, which employees learn through on-site training, on-the-job training and mentoring programs, and off-site training and educational workshops.

Additional training is critical for any new equipment or operational procedures that result from the implementation of sustainability initiatives. The Airport coordinates with the Training department to ensure proper training is provided by experienced trainers. Capital projects include approximately two hours of training for staff, as applicable, in the budget.

O&M Budgeting

The Maintenance Department's average annual budget is approximately $51 million; purchases greater than $5,000 typically are included in the capital budget. PIT generates monthly reports that document the status of the current year budget. These progress reports are used to track and potentially adjust the budget for the following year. The budget preparation process begins with data collection—the Finance department provides budgetary information for previous years (typically a 10-year history). Additional information is gathered within the department for new costs (e.g., utility agreements for the next year, material costs, equipment rental costs, new contractor rates, etc.). This information is used by the Facilities Maintenance staff to create a draft budget. There are several reviews, revisions, and approvals including the Department Director, Chief Operations Officer, Chief Financial Officer, and Chief Executive Officer, with final approval by the Board of Directors.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, PIT considers the expenses of highest importance to be:

- Staff salaries,
- Utility bills, and
- Contractor costs.

In addition, PIT also considers the return on investment. If acceptable, the initiative would be accounted for in the budget. If not acceptable, a further review of the initiative would be performed focusing on questions such as whether it is mandated by a government entity, would the project improve customers' experience, if the project improves the environment, and other positive and/or negative impacts the project would have. Once these questions are discussed as a group and answered, the Department Director would make the final decision whether to implement an initiative.

Funding Opportunities

The ACAA leased approximately 9,000 acres at PIT to Consol Energy to drill gas. This drilling won't start until after an environmental assessment is completed. The ACAA initially expected to receive about $500 million in royalties and fees over the life of the lease, but it may be more depending on the number and efficiency of the wells.

O&M Performance

Performance metrics detailed in this section are most useful for PIT's budget planning and timing of investments. When assessing the impact of sustainability initiatives on O&M activities, the Airport considers the performance metrics of highest importance to be:

- Managing/maintaining the budget;
- Cost per enplanement;
- Airport compliance with regulations;
- Resource consumption;
- Occupational health and safety;
- Customer service;
- Ensuring continuity of operations; and
- Contribution to airport strategic goals (passenger satisfaction, environmental stewardship, and cost reduction).

In addition to the metrics above, safety and customer service are main reasons for implementing initiatives. PIT also considers union support, staff time available or cost of outside consultants,

safety concerns involved with the project or after implementation, schedule from planning until completion, hiring of additional staff after implementation, and many other issues prior to deciding whether to implement an initiative.

PIT utilizes the following tools to track and monitor performance: Honeywell Building Management System data logs, JD Edwards work order system information, Kronos time-keeping system, asset management system reports, operational budget monthly reports, baggage handling system software reporting, utility usage reports, handwritten material usage tracking forms, and many other different types of tools.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, PIT would be willing to spend four or more hours using the EP&CBT. PIT would have 12 to 18 users, and would like the tool to track user names.

For PIT, the most important metrics to include in the tool are staff-hours necessary (before and after implementation), the cost of the proposed initiative (material and labor), impact to the O&M budget (positive or negative), and payback period.

The Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate a custom time period;
- Provide default standard cost factors (labor rates by trade, material costs, training costs);
- Evaluate the impacts for a group of sustainability practices;
- Flag high-risk issues (union impacts, temporary runway closure/inoperable equipment, safety, customer service concerns);
- Sort/rank impacts;
- Provide summary information; and
- Export to MS Excel or PDF.

PIT also recommended a dynamic tool that is updated as necessary, so as to not become outdated.

E.10 Seattle-Tacoma International Airport

General Information

Seattle-Tacoma International Airport (SEA) is located in SeaTac, Washington. According to FAA's NPIAS, SEA is a large hub airport. The Airport is owned and operated by the Port of Seattle and has approximately 850 FTE employees (excluding tenants).

Sustainability at the Airport

SEA established a formal sustainability program in 2009. In addition, the Airport is also participating in the FAA's sustainability pilot program. Examples of sustainability initiatives implemented at SEA include:

- Waste reduction and recycling;
- Implementation of energy efficiency and energy conservation measures;
- Air quality and greenhouse gas reduction (converting diesel ground support equipment to electric (e-GSE) and adding infrastructure and preconditioned air (PCAir));

- Improved fleet efficiency, SEA wants to be GreenFleet certified by the end of 2013;
- Natural gas reduction measures (terminal efficiency improvements);
- Working towards transitioning to biomethane/landfill gas;
- Use of green technologies [iPhones are integrated; demand management system for parking; Quick Response (QR) codes used for public outreach];
- Transportation changes: increase passengers per vehicle coming to the airport, increase bike access, and explore a car-sharing program;
- Sustainable design in order to green-certify buildings;
- Tracking and maintaining assets to calculate the total cost of ownership to help with efficiency and projections;
- Implementation of education and public outreach activities including a window cling program (icons have a sustainability "look" and includes a QR code, which provides additional information to educate passengers); and
- Collaboration with 40+ stakeholders to create aviation biofuels.

Challenges

When selecting initiatives for implementation, SEA faces a number of challenges. SEA must consider scheduling and resource conflicts (staff availability). It requires a lot of collaboration amongst all relevant parties/departments.

Unexpected Outcomes

SEA has experienced positive outcomes from sustainability initiatives. For example, the Airport was able to reduce costs to airline tenants as a result of the e-GSE and PCAir projects.

The Airport noted that everything has unforeseen impacts. The e-GSE program encountered complications because the airlines have to purchase the electric vehicles and the Airport has to install charging stations, but it wasn't clear who should make the first step/purchase.

O&M Involvement

O&M employees assist with selecting which sustainability practices should be implemented. Data for evaluating a proposed sustainability initiative that may be considered include financial impacts and project costs.

O&M Activities

O&M activities are conducted within the Aviation Facilities and Infrastructure, Aviation Maintenance, and Aviation Operations departments. There are more than 600 employees supporting O&M activities within these departments; which don't include janitorial, elevator and escalator, and other contracted services/staff.

Tracking O&M Activities

SEA uses Maximo for its computerized maintenance management system for tracking all maintenance activities and costs. Activities tracked include on-time completion rate, whether work was proactive or reactive, failures, and cost per asset.

Training and Expertise

SEA provides Airport-sponsored training, self-initiated off-site training, and on-the-job training. Specialized training as a result of sustainability activities is provided as needed; maintenance technicians have not yet needed much additional technical training as a result of sustainable practices implemented.

O&M Budgeting

SEA's annual combined O&M budget is approximately $100.5 million; purchases greater than $20,000 are included in the capital budget. Annually, individual departments develop and submit their respective O&M budgets to SEA's Senior Management for approval.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, SEA considers the following expenses important:

- Total cost of ownership,
- Equipment acquisition,
- Staff salaries,
- Utility bills, and
- Fuel costs.

Funding Opportunities

SEA has participated in FAA's VALE program and has received funding to provide charging stations for e-GSE.

O&M Performance

Performance metrics detailed in this section are most useful for SEA's budget planning, timing of investments, and assessment of system and facility performance. When assessing the impact of sustainability initiatives on O&M activities, the Airport considers the performance metrics of highest importance to be:

- Cost per enplanement;
- Airport compliance with regulations;
- Resource consumption; and
- Ensuring continuity of operations.

The needs of the traveling customer and airlines are the most important considerations for the Airport. SEA tracks six key environmental metrics and 15 to 20 other metrics for their environmental strategy plan. Maximo tracks SEA's key performance indicators (KPI), such as on-time project manager completion rate at or above 85%.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, the Airport would be willing to spend four or more hours using the EP&CBT. The time spent to evaluate initiatives would be relative to the size and complexity of the project with respect to the total cost of ownership.

The most important data to include in the tool for SEA are full-time employee impacts, life-cycle costs, energy savings, waste reduction, and facility resource requirements. Additionally, SEA would find it useful to capture all O&M costs to be provided in an editable format.

Additionally, the Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate a 5-year time period, projected out to the expected life of the facility/project;
- Provide default standard cost factors (labor rates, greenhouse gases, and usage of electric, fossil fuels, water, and waste);
- Evaluate the impacts for a group of sustainability practices;
- Flag high-risk issues (reliability and availability, leading-edge/new technology);

- Sort/rank impacts;
- Provide summary information; and
- Export to MS Excel/PDF and presentation software such as PowerPoint or Tableau.

E.11 Tucson International Airport

General Information

Tucson International Airport (TUS) is located seven miles from the central business district of Tucson, Arizona. According to FAA's NPIAS, TUS is a medium hub airport. The Airport is owned and operated by the Tucson Airport Authority (TAA) and has approximately 300 FTE employees (excluding tenants).

Sustainability at the Airport

TUS does not have a formal sustainability program or policy. Sustainability initiatives are implemented on an ad-hoc basis and examples include:

- Installation of a hydrant aircraft fueling system;
- Addition of a 400 Hz ground power system to the hydrant aircraft fueling system;
- Addition of variable frequency drives to pumps, fans, and air handler motors;
- Outreach program for employees and tenants that raised awareness about managing resources carefully and reducing utility consumption;
- Installation of a building automation system;
- Installation of hands-free faucets in all restrooms;
- Installation of a new energy-efficient chiller and boiler central plant;
- Installation of a second energy-efficient chiller and conversion of the chilled water system to a single loop configuration; and
- Installation of photovoltaic solar arrays.

Challenges

In the past, Airport divisions operated independently and information wasn't shared between departments. For example, during the replacement chiller project, there was poor communication between Engineering and Maintenance regarding routine maintenance. A catwalk was cut from the engineering design because the project was low on funding. As a result, staff couldn't perform routine maintenance appropriately without the catwalk; now the equipment isn't as effective and a catwalk will be added to assist maintenance.

Unexpected Outcomes

TUS installed waterless urinals several years ago, but these were not well received. Most have since been replaced with low-flow urinals.

O&M Involvement

TUS doesn't have a formal process for implementing sustainability initiatives. Depending on the project, O&M employees assist with identifying sustainability practices and evaluating the O&M-related costs and benefits of the practices and participate in the selection of sustainability practices. Data for evaluating a proposed sustainability initiative that may be considered include utility consumption/savings, cost–benefit analysis, and total cost of ownership.

O&M Activities

All O&M activities are conducted under the Operations & Maintenance department. Sub-departments include Ryan Airfield (TAA's general aviation airport), Airfield Operations, Airport

Communications Center, Maintenance (Airfield, Facilities, and Fleet), and Custodial Services. Approximately 80 employees are involved in O&M activities at TUS.

Tracking O&M Activities

The Airport uses GCR's Airport Business Manager (ABM) program to enter and track work orders, order materials, and track resources. TAA rolled the ABM software out so quickly that users became overwhelmed and it is not used correctly or to its fullest extent. When users aren't able to find the assets in the system, work may be completed without tracking.

Training and Expertise

TUS provides Airport-sponsored training, self-initiated off-site training, and on-the-job training. The Airport is currently in the process of determining required, industry, and recurring training needs. To support this, the O&M department is developing a baseline to determine the training required and allocate resources appropriately through the budget process.

O&M Budgeting

The O&M department's average annual budget is approximately $29 million; purchases greater than $5,000 are included in the capital budget. The Senior Director of Operations and Maintenance will prepare the budget with the assistance from the key areas represented. The O&M Director will review items such as average O&M costs, resource allocation, and major maintenance to provide line item budgets. This is provided to management for review and the budget review group evaluates the overall budget based on projected revenue or specific need. The budget is approved by the senior management team and President/Chief Executive Officer.

Evaluating Sustainability Practices

When deciding whether to implement a sustainability practice, TUS considers the expenses of highest importance to be:

- Equipment acquisition,
- Inventory,
- Staff salaries,
- Training,
- Utility bills,
- Contractor costs, and
- Fuel costs.

TUS evaluates the expenses above and optimizes where possible. In addition to the above expenses, TUS also considers the cost for activities on the market. Personnel account for approximately 64% of the overall operating budget and TUS will use outside vendors for activities that are cheaper when not performed in-house (e.g., oil changes on fleet vehicles).

O&M Performance

Performance metrics detailed in this section are most useful for TUS's budget planning. When assessing the impact of sustainability initiatives on O&M activities, the Airport considers the performance metrics of highest importance to be:

- Managing/maintaining the budget;
- Cost per enplanement;
- Airport compliance with regulations;
- Resource consumption;
- Occupational health and safety;

- Customer service;
- Ensuring continuity of operations; and
- Contribution to airport strategic goals (passenger satisfaction, carrier relationship management, environmental stewardship, and cost reduction).

Additionally, the Airport wants to be a "friendly" airport to the community. Phoenix is approximately an hour away and TUS doesn't want to do anything to lose passengers. TUS also considers other aspects such as customer expectations. The Airport would still consider implementing an initiative that wouldn't have a cost benefit, if there would be a social benefit.

Tool Design

To evaluate the O&M impacts of a single sustainability practice, TUS would be willing to spend two to three hours using the EP&CBT. The Airport would prefer the tool to be easy to use.

The Airport considers the most important information to include in the tool to be asset type, age, lifecycle, manufacturer's recommendations, and total cost of ownership.

Additionally, the Airport suggested the following features of the tool would be valuable:

- Allow users to input actual data into the tool;
- Evaluate a five-year time period;
- Provide default standard cost factors;
- Evaluate the impacts for a group of sustainability practices;
- Flag high-risk issues;
- Sort/rank impacts;
- Provide summary information; and
- Export to MS Excel or PDF.

APPENDIX F

Focus Group Feedback

As part of the case study activities, three focus groups were held allowing airport representatives to use the tool and provide feedback. These focus groups identified numerous development actions that were considered for integration into the proof-of-concept and tool refinement. Table F-1 provides a summary of the focus group feedback received and the development actions identified.

Table F-1. Focus group feedback and tool development actions.

Feedback Category	Description of Feedback	Development Action Taken
General	Some users were concerned that they would still be responsible for making all needed calculations behind the scenes/outside of the tool. Some users had to gather a lot of information from outside of the tool in order to go through the evaluation process. Moreover, there was a lack of understanding from certain users regarding the intended audience/users of the tool.	N/A – This is consistent with the intended use and scope of the EP&CBT: it serves as a framework and "memory jogger" to think through and aggregate all the relevant cost factors. Specific engineering estimates are still expected to be developed outside of the tool; therefore no development action is needed. Based on case study interviews, it is not consistent who will be entering data at each airport; therefore the tool should be universally accessible, even if the user needs to gather data from outside sources. The tool was developed so that deep understanding of finance is not required to use it.
	Users desired better visibility of what the tool is doing. Users would have liked to have access to a screen or a clickable "help" function to get access to the definition of terms used (this refers to cost entry but is general insight). Users also reported that definitions are not always clear.	More information was provided throughout the tool. The project team assessed and improved upon definitions and provided help windows to define terms and functions on each page.
	One user suggested including a section with an abstract summary of all benefits/impacts of the sustainability practice being evaluated.	Section with abstract summary of all benefits/impacts was included. This was made to be an automated summary, and could also allow user to enter summary.
	One user commented that discount rates should only be applied to capital projects.	This only applies to NPV calculations. Applying NPV to all costs still provides a useful output option primarily to compare costs between investment options, therefore no action was taken.
	All users wished the tool included ability to compare multiple practices simultaneously or the ability to store and visualize the O&M costs and benefits of a "portfolio" of sustainability practices.	The ability to compare the outputs of multiple practices could be developed for future tool expansions.
	One user suggested that the overall EP&CBT was too complex for simple sustainability projects, and suggested there could be a complementary "short" or "abridged" version.	This may not be necessary, as the user can skip sections for simpler projects. This goes back to a previous comment about providing better definitions and guidance regarding the tool functionalities. The tool was revisited and streamlined while increasing functionality.
	Users recommended locking data and tabs to prevent unintentional tampering with the tool structure and formulas.	All data and calculations were locked within the tool.

Table F-1.   (Continued).

Feedback Category	Description of Feedback	Development Action Taken
Evaluation Process	Regarding the evaluation process, users felt that certain cost categories seemed to be overlapping (e.g., "training" costs are present both in Startup and Operations & Maintenance). Likewise, the tool would benefit from a better definition of cost categories; for instance, the distinction between "Spare Parts" and "Equipment" is not clear.	A review was conducted of the EP process/ categories to consolidate/streamline and modify: - For internal consistency in form, - To include all relevant categories, and - To keep categories from overlapping.
	"Legal/Compliance" costs typically do not fall under O&M responsibility.	Environmental legal/compliance costs are especially relevant in this case. These costs will remain to highlight "environment-related" compliance costs, and can be skipped if needed.
	One user suggested to take into account the differences between escalation rates of costs factors such as labor or electricity every year.	Forecasting labor and electricity escalation rates is out-of-scope for the development of this particular tool and will not be included. However, this could be considered in a future, enhanced version of the tool.
Cost Entry	Some users found it difficult to enter baseline and sustainability project costs simultaneously. Existing baseline costs and new sustainability costs do not necessarily fall within the same cost categories.	Baseline and sustainability practice cost entry methods were separated into different processes.
	In general, users found it difficult to edit previously entered data.	Clearly visible buttons were added for each cost item in the input worksheets to enable the user to edit costs.
	Some users commented that in general, the cost entry tables appeared inflexible in terms of granularity of components, flexibility of units.	The scope and capabilities of the non-aggregate cost entry format were expanded to - Provide flexibility in entering replacement timeline (frequency with which costs are incurred) and - Provide additional information explaining the cost entry method and that costs can be entered at whatever granularity makes the most sense in the user's case.
	Users asked for additional clarifications regarding the cost entries related to the "Sustainability Practice Identification" categories.	Additional information was provided. Incorporated bottom two parts of Sustainable Practice Identification (Sustainable Practice Type and Airport Functional Area) into rest of tool by including in output.
	Several users inquired whether the tool could include a database of "typical" or "standard" sustainability practice cost components that they could use to enter costs.	Because the tool is intended to be used by a variety of airport types across the country, and because cost components can be highly scenario and airport-specific, it is difficult to provide a database of "standard costs," so this was not done. This tool intends to serve as a framework and "memory jogger" to think through and aggregate all the relevant cost factors that should be gathered by the user his/herself. Specific engineering estimates are still expected to be developed outside of the tool.

Table F-1.   (Continued).

Feedback Category	Description of Feedback	Development Action Taken
Performance Impacts	Several users provided feedback regarding the "Performance & Qualitative Impacts" section of the tool. General comments included: - The lack of explanation of the ratings systems for assessing performance impacts, - The lack of customization of the performance/qualitative metrics, and - The lack of visibility of performance metrics in the subsequent Outputs section.	Additional information and definitions were provided. Users were provided with methods for entering their own categories. Output was moved adjacent to the Cost Output. Output was also improved to better convey relative information.
Outputs	Regarding the "Outputs – Graph" tabs, users suggested making the "View Individual Cost Items" function more accessible and more clear.	Additional information was provided. Input options were provided in a more accessible format.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation