Outcomes of Green Initiatives: Large Airport Experience

DETAILS

64 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-27135-6 | DOI 10.17226/22393

AUTHORS

Airport Cooperative Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

BUY THIS BOOK

FIND RELATED TITLES

ACRP SYNTHESIS 53

Outcomes of Green Initiatives:
Large Airport Experience

A Synthesis of Airport Practice

CONSULTANTS
Barbara Thomson
First Environment, Inc.
Boonton, New Jersey
and
Elizabeth Delaney
First Environment, Inc.
Boonton, New Jersey

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2014
www.TRB.org

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.

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

TOPIC PANEL S02-10
STEPHEN BARRETT, *Harris Miller Miller & Hanson Inc., Burlington, Massachusetts*
AMY MALICK, *Chicago Department of Aviation*
PAUL R. MANASJAN, *San Diego County Regional Airport Authority*
LYNE MICHAUD, *Aeroports de Montréal*
ARLYN PURCELL, *Port Authority of New York & New Jersey*
MEGAN S. RYERSON, *University of Pennsylvania*
BURR STEWART, *Burrst, Seattle, Washington*
PATRICK MAGNOTTA, *Federal Aviation Administration* (Liaison)

SYNTHESIS STUDIES STAFF
STEPHEN R. GODWIN, *Director for Studies and Special Programs*
JON M. WILLIAMS, *Program Director, IDEA and Synthesis Studies*
JO ALLEN GAUSE, *Senior Program Officer*
GAIL R. STABA, *Senior Program Officer*
DONNA L. VLASAK, *Senior Program Officer*
TANYA M. ZWAHLEN, *Consultant*
DON TIPPMAN, *Senior Editor*
CHERYL KEITH, *Senior Program Assistant*
DEMISHA WILLIAMS, *Senior Program Assistant*
DEBBIE IRVIN, *Program Associate*

COOPERATIVE RESEARCH PROGRAMS STAFF
CHRISTOPHER W. JENKS, *Director, Cooperative Research Programs*
MICHAEL R. SALAMONE, *Manager, Airport Cooperative Research Program*
JOSEPH J. BROWN-SNELL, *Program Associate*
EILEEN P. DELANEY, *Director of Publications*

ACRP COMMITTEE FOR PROJECT 11-03

CHAIR
JULIE KENFIELD, *Jacobsen/Daniels Associates, Garden Ridge, Texas*

MEMBERS
RANDALL P. BURDETTE, *Virginia Department of Aviation*
KEVIN C. DOLLIOLE, *Unison Consulting, Inc., Chicago, Illinois*
LINDA HOWARD, *Bastrop, Texas*
ARLYN PURCELL, *Port Authority of New York & New Jersey*
BURR STEWART, *Burrst, Seattle, Washington*

FAA LIAISON
PAUL DEVOTI

AIRCRAFT OWNERS AND PILOTS ASSOCIATION
JOHN L. COLLINS

TRB LIAISON
CHRISTINE GERENCHER

Cover photo illustration: First Environment, Inc.

FOREWORD

Airport administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the airport industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire airport community, the Airport Cooperative Research Program authorized the Transportation Research Board to undertake a continuing project. This project, ACRP Project 11-03, "Synthesis of Information Related to Airport Practices," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an ACRP report series, *Synthesis of Airport Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Gail R. Staba
Senior Program Officer
Transportation
Research Board

Airports are embracing green initiatives to address compliance issues, reduce their environmental footprint, and increasingly, as strategic components of the airports' long-term prosperity and success.

This report presents information from literature and a survey that explores the drivers and outcomes of green initiatives, as well as identifies data used to evaluate their effectiveness. Case studies from interviews of 15 airport managers describe specific green initiatives, including drivers, outcomes, and lessons learned. The report will be of special interest to airport managers, staff, and researchers involved in developing, implementing, and tracking green initiatives at airports.

Barbara Thomson, First Environment, Inc., Boonton, New Jersey, and Elizabeth Delaney, First Environment, Inc., Boonton, New Jersey, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

_____

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.

OUTCOMES OF GREEN INITIATIVES: LARGE AIRPORT EXPERIENCE

SUMMARY   Airports are embracing green initiatives to address compliance issues, reduce their environmental footprint, and increasingly as strategic components of the airports' long-term prosperity and success. Many of the environmental practices airports have employed have resulted in triple bottom line improvements: that is, improvements to the environment, to society as a whole, and to the long-term economic outlook for the airport.

This study was undertaken to explore the drivers and outcomes of green initiatives. It presents perspectives and technical data from airports about green initiatives. The synthesis focuses specifically on understanding the drivers and outcomes of the green initiatives—how they have had a positive impact on the environment, financial performance, and in some cases the community surrounding the airports. The survey included 15 airports, primarily large hubs that have adopted partially or fully developed sustainability practices. Airport personnel were queried about drivers, barriers, and benefits to green initiatives, and about the organizational governance that supported the green initiatives. The airport staffs were given the opportunity to provide details on as many as 10 sustainability practices each. Initiatives were separated into categories derived from the Global Reporting Initiative (GRI) *Sustainability Reporting Guidelines & Airport Operators Sector Supplement* (2011).

The 15 airports reported a total of 88 practices. Every category from the GRI-derived list was represented in the practices. The most widely identified initiative category was "waste and recycling." Others included, in order of number of practices represented, green transportation; energy, water resources, wastewater, and stormwater; air quality and greenhouse gas (GHG); green buildings; noise; green construction; material purchasing and use; life-cycle assessment; land use, biodiversity, wildlife management, and restoration; and adaptation to climate change. In interpreting the practice categories, it should be pointed out that practices often fall into multiple categories. For example, an energy efficiency practice may also decrease air emissions and GHGs. The survey was structured so that it could be repeated in the future for purposes of comparison and comment on the evolution of the green initiatives.

Personnel of 12 of the 15 airports also contributed case examples that provide specific details of how they identified, implemented, and assessed a specific green initiative at their airports. The case examples help in understanding the drivers, outcomes, and lessons learned with a specific practice. The outcomes included measurements of performance and cost in some cases; in other cases, the outcomes were qualitative in nature and reflected benefits such as recognition in the community or improved relationships with stakeholders.

The combination of surveys and case examples has provided the opportunity to explore common themes in implementing green initiatives. Drivers for green initiatives often reflect characteristics unique to the airport and the community in which it exists. Often the initiatives are not stand-alone but are critical components of the airport's mission and overall strategy for continued growth and success. It is also clear that airport personnel are more than willing to share their knowledge and experience with their colleagues, but that the shared practices are then tailored to the specific situation and need. Another theme that was supported by survey results and case examples was that cost savings often make an initiative attractive, even though cost savings was listed as a relatively low-priority driver for programs. Organizational governance and a process to support green initiatives

2

are shown to be of critical importance in implementing practices. In particular, environmental management systems (EMSs) were mentioned as tools for establishing appropriate organizational governance. Another area of consensus was the importance of assessing and reporting performance, although there was a fair amount of variation in how this was done.

Finally, personnel from all the airports recognized that their green initiatives had brought substantial benefit to the airport in improving their sustainability performance, recognition in the industry, and management confidence. Risk reduction, protection of environmentally sensitive receptors, improved compliance and regulator relations, and improved tenant and customer relationships were also highly ranked benefits.

CHAPTER ONE

INTRODUCTION

BACKGROUND

Airport staffs have increasingly recognized the importance of introducing green initiatives into all aspects of airport planning and operations, not only for the environmental benefit but increasingly because staffs recognize that green initiatives contribute to the financial success of the operation and lead to social benefits within the communities served. This report, *ACRP Synthesis S13-02-10: Outcomes of Green Initiatives: Large Airport Experience*, provides the results of a survey of U.S. and Canadian airports that identifies and analyzes green sustainability initiatives being implemented by airports; the drivers behind implementation; and the outcomes. In addition to the survey results, the study includes multiple case examples that provide a better understanding of how airports developed their green practices and the governance, structures, and processes that underlie and support the development of the green practices. The case examples augment and expand on the general survey to provide specific examples of how green practices have been implemented at airports. The study aimed to present the data in a manner that would assist airport staffs in better understanding how green initiatives are incorporated into operations, and the initiatives' potential outcomes.

In seeking to understand the drivers for green initiatives, the synthesis considers not only performance improvements, but also more general expectations, such as those of the community and the airport staffs. Similarly, outcomes, as examined within the synthesis, include performance data and outcomes that are qualitative in nature and important in understanding how the initiatives fit within a larger airport and community context.

The study focuses on collecting information from specific airports on their actual practices. It does not include the independent collection of data and does not provide comprehensive information on the status of sustainability across the airport industry. Trends were not identified; however, common themes across the reporting airports have been identified.

The study is intended to build on and augment 2010 *ACRP Synthesis 10: Airport Sustainability Practices* and two ongoing ACRP studies: *ACRP Report 02-28 (Active) Airport Sustainability Practices: Tools for Evaluating, Measuring and Implementing*, and *ACRP 02-30 (Active): Enhancing the Airport Industry SAGA Website. ACRP Synthesis 10* found that airports were focusing on holistic approaches to sustainability and practices, and the most current initiatives at the time focused on environmental improvements. ACRP Reports 02-28 and ACRP 02-30 are being prepared in coordination, with the intention of assisting the airport industry with sustainability tool guidance to gauge performance better. Furthermore, the breadth and depth of airport sustainability practices vary, so the studies are being done with the intent of allowing all practices to be evaluated on the same rating system.

AUDIENCE

This synthesis is specifically targeted to airport operators, airlines, and airport tenants. Other stakeholders in the aviation industry may find the study valuable. It will be particularly worthwhile to those with interest in or responsibility for sustainable practices.

4

SYNTHESIS CONTENT

The report is organized as follows:

- Chapter two: Study Methodology
- Chapter three: Literature Review
- Chapter four: Survey Respondents
- Chapter five: Survey Results
- Chapter six: Green Practices with Case Examples
- Chapter seven: Conclusions

CHAPTER TWO

STUDY METHODOLOGY

To provide a comprehensive synthesis of drivers and outcomes of green initiatives at airports, the synthesis study consisted of three parts: a literature review, an electronic survey of airport green practices, and the development of case examples to illustrate airport experience with specific green practices.

LITERATURE REVIEW

The literature review was completed to identify the current state of sustainability, particularly green initiatives at airports, so this ACRP synthesis could start where other studies have left off and provide a framework based on established reporting methods. The results of the literature review are summarized in chapter three. In addition, the results of the review have informed the general content of the synthesis and in particular the electronic survey.

SURVEY PARTICIPANTS

With assistance and guidance from the topic panel, U.S. and Canadian airports that have experience with implementing green initiatives were identified for possible participation in the synthesis. A variety of airport types were included in the survey. Representatives from each identified airport were asked to participate in the study in a telephone interview during June and July 2013. If the airport staff agreed to participate, they were asked to complete a longer electronic survey designed to collect additional information on the status of green initiatives at their airport. Fifteen airports agreed to participate in the survey, for a 100% participation rate. The airports that were interviewed and surveyed were eligible to participate in an in-depth interview to be used for developing 10 to 12 case examples.

Transforming the qualitative ranking into a quantitative ranking was done by assigning numerical values to indicate varying degrees in the qualitative response. For example, a question on benefits was scored as follows:

No benefit = 1
Moderate benefit = 2
Significant benefit = 3

SURVEY

The electronic survey, developed based on the literature review and topic panel contributions, was designed to reflect the green initiatives airports are undertaking. The telephone interview and electronic survey were provided to topic panel members before the commencement of the study, and their comments were incorporated before distribution.

All of the 15 airports completed the follow-up electronic survey in July and August 2013. (Appendix C lists participating airports.) The airports responded to a "tiered" survey and answered only the questions that applied based on their preceding answers. Questions were both qualitative and quantitative in nature.

ANALYSIS OF THE SURVEY

The results of the airport surveys were aggregated for analysis purposes. Some survey questions required the respondent to provide a qualitative ranking to the response regarding its degree of importance. To better assess, differentiate, and rank the collective responses to these types of questions,

6

those survey results were translated into quantitative measures. In some cases, question results were compared with those of others to test possible relationships.

CASE EXAMPLES

Twelve of the 15 airports that responded to the survey participated in in-depth interviews to provide case examples for understanding green initiatives and their outcomes. Airports were selected based on their responses to the survey so that the case examples would represent the greatest number of Global Reporting Initiative (GRI)-based categories used in the study, as well as practices they deemed as their greatest successes. Although the case examples describe specific practices, they are written to pull out "the lessons" and provide a perspective applicable to the implementation of other practices. The case examples are based on the in-depth interviews and supplemental material provided by the airport.

CHAPTER THREE

LITERATURE REVIEW

An initial literature review was undertaken to help shape the survey and case examples. After the survey, the literature review was expanded to supplement the survey findings. Relevant information from the literature survey is included here and referenced in this report. All documents reviewed, whether referenced or not, are listed in the annotated bibliography.

DRIVERS OF SUSTAINABILITY AT AIRPORTS

Airports are vital assets in the globally connected world and economy. "Major metropolitan airports are now an archetypal 'glocalization' in mediating the interaction between global forces and local environments" (Robertson 1995). As John Short (2004, p. 72) put it, "airports are not just nodes in the global network of flaws, they are sites of major environmental impact that highlight the tension between international connectivity and local livability" (Freestone and Baker 2011).

The demands on airport services continue to grow, so their direct and indirect environmental effects can be expected to expand in a similar manner. In recognition of this, many airports have begun focusing on sustainable expansion and green initiatives or their triple bottom line.

TRIPLE BOTTOM LINE

The term "triple bottom line" was coined by John Elkington (1997) and "measures the company's economic value; 'people account'—which measures the company's degree of social responsibility; and the company's 'planet account'—which measures the organization's environmental responsibility." This approach was founded on the concept that an organization, instead of focusing solely on its finances, should improve upon its social, economic, and environmental impact for the long-term survival of itself and society.

AIRPORTS AND SUSTAINABILITY

FAA has recognized the importance of environmental protection and green initiatives. Currently, these airport initiatives and programs align with sustainability's "triple bottom line" of "society, environment, and economy." According to the Office of Airport Planning and Programming (2012), ongoing initiatives include "Part 150" Noise Compatibility Planning Program (1984), Voluntary Airport Low Emissions Program (VALE 2005), Environmental Management System (2007), and numerous geothermal and solar projects. More recently, the Sustainable Master Plan Pilot Program includes plans to take "a more proactive, holistic approach to sustainable planning and creates a road map to identify ways to reduce energy consumption, reduce environmental impacts, realize economic benefits and become a better neighbor" (Office of Airport Planning and Programming 2012). In 2012, FAA published the "Report on the Sustainable Master Plan Pilot Program and Lessons Learned" that outlined numerous topics, including best practices, lessons learned, and notable sustainability initiatives that were undertaken. Under this directive, airports were allowed to choose between two sustainability plan types: sustainability master plan and sustainability management plan. Both approaches provide the same foundation for airports to build upon, beginning with creating a sustainability mission statement, providing sustainability categories that would be analyzed, developing baseline assessments, and involving the public and respective stakeholders (FAA 2012). In addition to the FAA pilot program, other outlets have provided airports with invaluable guidelines for starting, tracking, and reporting their green initiatives.

8

Similarly, a broad coalition of aviation interests from ACI–NA, ACI, AAAE, ATA, FAA, as well as consultants and other individuals, created the Sustainable Aviation Guidance Alliance (SAGA) to "assist airport operators of all sizes in planning, implementing, and maintaining a sustainability program" (SAGA 2013). This coalition provides essential tools that allow airports to define sustainability themselves by exploring the benefits of a metric-based sustainability system. Scalability is also essential in the eyes of SAGA, so the group provides resources to create unique sustainability programs or initiatives based on each airport's operating environment and resources.

The International Council for Local Environmental Initiatives (ICLEI) is an international conglomeration of local, regional, and national governments that have made a commitment to sustainable development. This association serves "as an information clearinghouse on local sustainable development by producing annual newsletters, regional updates on activities, case examples, training guides and fact sheets" (ICLEI 2013). This serves as yet another valuable asset for airports that are looking for catalysts to develop long-term sustainability initiatives while partnering with local or regional governments. ACRP has been publishing annual synthesis studies on sustainability efforts, green initiatives, and similar progressive best practices; these reports have given the industry insight on how to improve operations and management. Sustainability practices at airports have been documented in *ACRP Synthesis 10: Airport Sustainability Practices* (Berry et al. 2008). That synthesis studied the range of airport sustainability practices by targeting the input of airport operators and their efforts to improve upon their triple bottom line. The study found that the airport industry as a whole is moving toward a more holistic approach to sustainable practices and operations, with most current initiatives focusing on environmental improvements.

Other recently published and working reports include *ACRP Report 57: The Carbon Market: A Primer for Airports* (Ritter et al. 2011); *ACRP Report 02-28 (Active): Airport Sustainability Practices: Tools for Evaluating, Measuring and Implementing;* and *ACRP Report 02-30: Enhancing the Airport Industry SAGA Website.* ACRP 02-28 and ACRP 02-30 are being researched in coordination with one another. The intentions of these active studies are to assist the airport industry by identifying practices and providing sustainability tool guidance to gauge performances better. Because the breadth and depth of airport sustainability practices vary for each airport, these studies will allow all practices to be evaluated on the same rating system. This will allow for a better understanding by all stakeholders and a more sustainable approach to planning, construction, maintenance, and daily operations. The focus of these studies will allow airports to evaluate and select sustainability best practices and provide continual sources of information on the SAGA website.

TRENDS IN REPORTING AND RATING

Within the past few years, a number of reporting and rating systems have been developed. They include the GRI; ACI's "Guide to Airport Performance Measures"; and "Envision." Leadership in Energy and Environmental Design (LEED) is an internationally recognized green building certification developed by the U.S. Green Building Council (USGBC) in 2000.

In 2011 GRI published the *Sustainability Reporting Guidelines & Airport Operators Sector Supplement* to tackle the "unique sustainability challenges and opportunities, and the high degree of organizational and operational complexity associated with airports." This sector supplement tailored the GRI Guidelines (G3.1) to the airport industry. In May 2013, GRI launched its updated set of guidelines "the G4—the fourth generation." Sector supplement content and indicators from the Airport Supplement, based on G3.1, can be used in conjunction with the new G4. The G4 should lead to meaningful reports that include material topics only. As such, an airport should select only the topics and metrics from the GRI guidelines and its supplements that are deemed relevant to the company and its key stakeholders.

Before publishing these resources, GRI conducted market-specific research to establish trends for the airport industry for the year 2007. The study found a significant increase in environmental sustainability reporting in the airport sector, but sustainability still was not commonplace on the international level. In addition, the study identified multiple shortcomings and gaps in its own GRI guideline indi-

cators that were covered in airport sustainability report formats. This study helped the GRI develop the 2011 *Sustainability Reporting Guidelines & Airport Operators Sector Supplement*, a reporting benchmark for sustainable and green initiatives to be compared within and between airports.

Another reporting structure is the ACI *Guide to Airport Performance Measures*, which was released in 2012. It provides airports a way to assess performance in six key performance areas.

"Envision" is a rating system for sustainable infrastructure that was developed by the Institute for Sustainable Infrastructure (ISI) in partnership with the Zofnass Program at the Harvard Graduate School of Design in 2011–2012 (http://www.sustainableinfrastructure.org/rating/index.cfm). The American Council of Engineering Companies (ACEC), American Public Works Association (APWA), and ASCE founded ISI because they saw the need for a standardized framework for the classification of sustainability practices. They worked together to develop and administer a sustainable infrastructure rating system. The rating system assesses projects and provides a guidance tool for sustainable design. The framework provides criteria and performance achievements for users to identify sustainable approaches to plan, design, construct, and operate infrastructure projects. Envision provides a framework for evaluating and rating the community, environmental, and economic benefits of all types of infrastructure projects for the life of the project. Envision also trains Envision sustainability professionals, who are trained and credentialed by ISI. ISI provides an independent, third-party verifier who works with the Envision sustainability professional to validate his or her assessment of a project.

Since 2000, the U.S. Green Building Council's LEED has provided a rating system for green building design, construction, operations, and maintenance. LEED ratings recognize several levels of performance: LEED, LEED Silver, LEED Gold, and LEED Platinum, the highest ranking (see Figure 1).

FIGURE 1 Green roof.

10

CHAPTER FOUR

SURVEY RESPONDENTS

All 15 airports completed the follow-up electronic survey in July and August 2013, a 100% participation rate. (Appendix C lists participating airports.) The answers were self-reported, and no independent verification of the answers was undertaken. Owing to the sample size, responses are shown by the number of airports that responded and not by percentages.

The survey attempted to include airports that are generally representative of the airport industry. However, 12 of the 15 airports that agreed to participate in the study are classified as large hub by the U.S. DOT FAA. The remaining three are classified as medium hub. No small hub airports were included because the only small hub identified for the survey declined to participate. Geographically, the airports are spread throughout the United States and Canada, as shown in Figure 2.

FIGURE 2 Map of survey.

CHAPTER FIVE

SURVEY RESULTS

The synthesis sought to define the current status of green initiatives at airports with regard to maturity, drivers, and governance.

MATURITY OF SUSTAINABILITY PRACTICES

To assess the maturity of the airports' green initiatives, the airports were asked to characterize whether their practices are primarily compliance oriented; included some sustainability practices that were not related to compliance; or were fully developed with sustainability practices in place. All 15 of the airports reported falling within the latter two categories, indicating fairly substantial movement beyond compliance practices only. The majority (nine) reported their practices included noncompliance–related sustainability practices. Six characterized their programs as fully developed.

DRIVERS FOR AIRPORT SUSTAINABILITY EFFORTS

To provide better understanding of the reasons behind the adoption of sustainability efforts, the airports were asked to rank a series of potential drivers from very important to not important. The drivers were developed considering the 2010 ACRP sustainability study. As was found in 2010, the survey respondents ranked compliance as the most important driver (Figure 3). Rounding out the top five drivers, they ranked cost reductions, desire for improved sustainability performance, neighbors and community, and leadership in the industry.
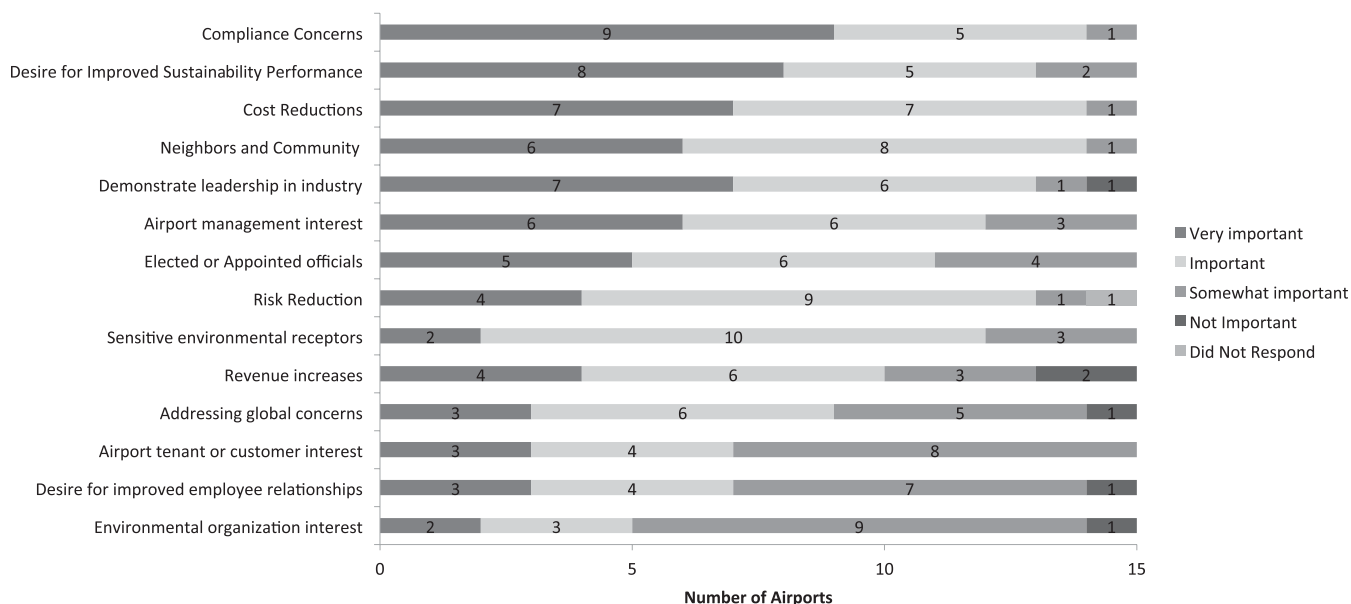
FIGURE 3 Drivers for green initiatives.

12

ORGANIZATIONAL GOVERNANCE OF GREEN INITIATIVES

A series of questions asked respondents to assess the management, organization, and structure that have been developed to support green initiatives. All the airports responded that their sustainability initiatives were founded in a sustainability policy. In addition, six of the 15 airports reported using an environmental management system (EMS) to manage their green initiatives. Of these six, four were certified to ISO 14001. Of the airports with an EMS in place, only one reported having an established sustainability program with fully developed practices in place.

Planning Processes

The airports were also asked whether they had a formal sustainability planning process. Twelve of the 15 respondents reported having an established process. Seven airports coordinate the process with their budgeting process, which is indicative of a level of integration with general airport planning. When asked about participation in the planning process, all airports with planning processes for sustainability identified that airport management is involved. Most also included the environmental and operations and maintenance departments in their planning. Far fewer airports included involvement by stakeholders who are not part of the airport organization, such as tenants, operators, and the public, indicating that only some airports hold a broader view of the stakeholder's role in the process (Figure 4).

Resources Used to Develop Sustainability Programs

When asked about the resources they had relied on to develop their sustainability programs, all survey respondents reported having relied on their internal environmental staff. Other internal resources used included operations and/or maintenance staff (reported by 14); accounting, administrative, or finance staff (9); and internal health and safety staff (6). External resources used included external consultants (12); industry trade groups or nonprofit groups (11); and external training (4). The airports were also asked to report other resources. Of the resources listed by name, half could be categorized in the industry or nonprofit group category (Figure 5).
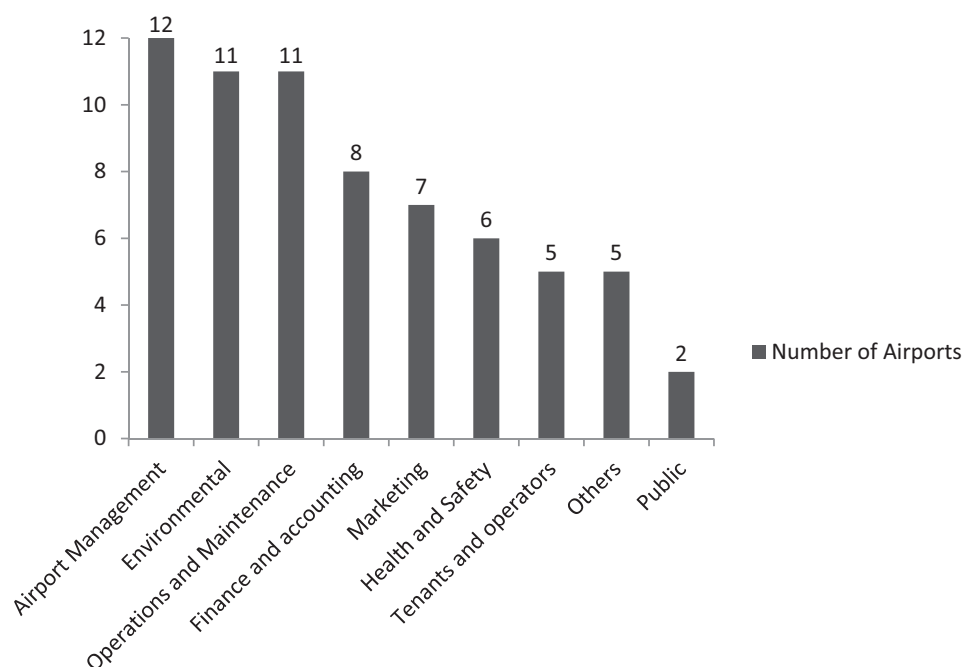
FIGURE 4 Groups involved with planning process.
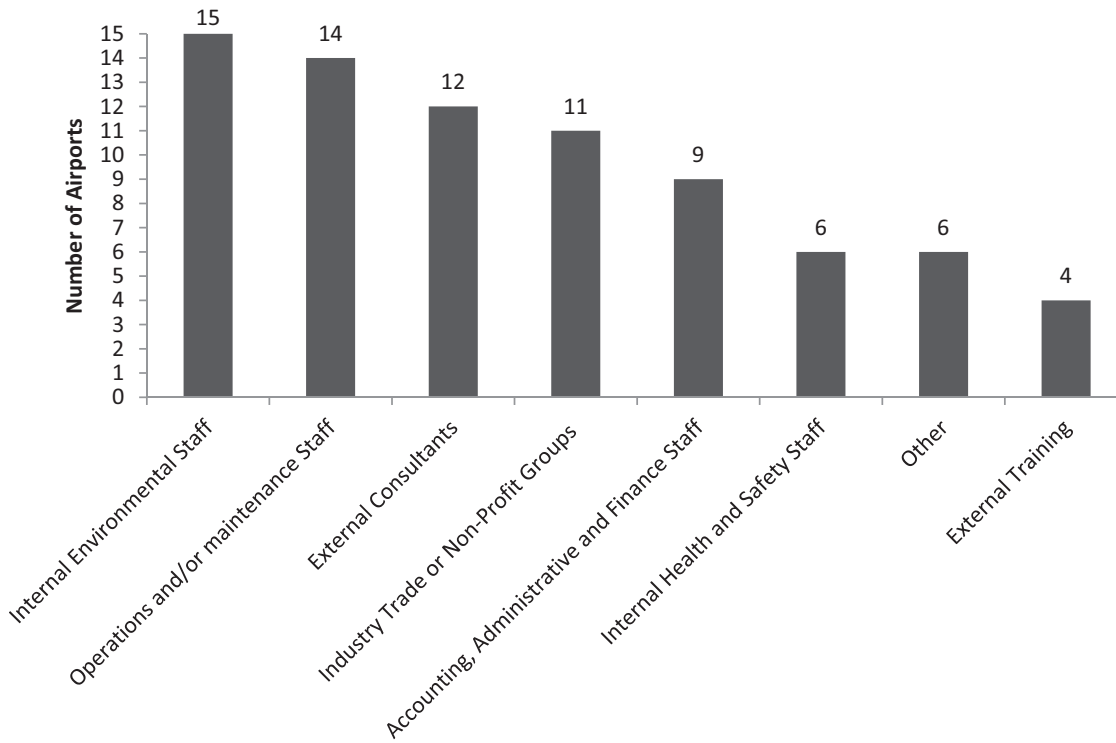
FIGURE 5 Resources utilized.

Roles in Implementing Practices

The airports were also queried as to the roles played by various groups in the implementation of their green initiatives. Most of the respondents reported that the internal environmental staff had a leadership role; the few who did not reported that a supporting role for internal environmental staff. Airport management was the next most identified group to have a leadership role. Again, if they were not identified as having a leadership role, they had a supporting role, an indication that the green initiatives are high-profile airport activities. For some airports, operations and maintenance, finance and administration, and marketing also performed leadership roles. More than half the airports identified outside groups that operate on the airport or on behalf of the airport as having supporting roles, reinforcing the finding that airports are recognizing that sustainability challenges extend beyond organizational boundaries (Figure 6).
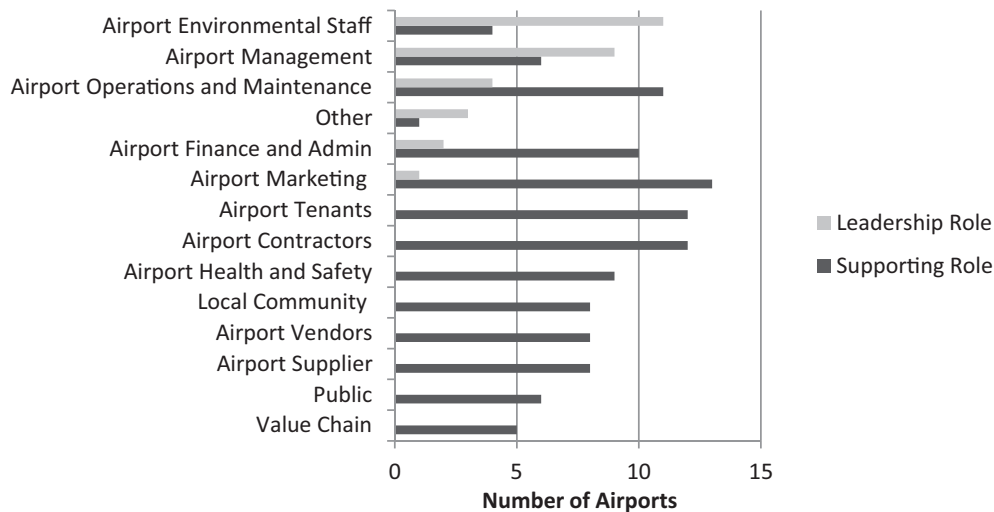
FIGURE 6 Roles in implementing sustainability practices.

14

TABLE 1
ACCESS TO COMMUNICATION TOOLS

Tool	Environmental Staff	Operations and Maintenance	Tenants	Public
Sustainability report	12	10	10	11
Shared drive	12	9	0	0
Intranet or Internet website	10	11	8	12
Database	10	10	0	0
Noise monitoring software	10	10	8	11
Flight tracking software	8	9	6	8
GIS	7	7	2	2
Other	1	1	1	0

Source: First Environment, Inc.

Tools Used to Support Practices

The 15 airports were surveyed with regard to the tools they use to support and communicate their sustainability. The airports use a combination of the following:

- Sustainability report,
- Internet or intranet website,
- Noise monitoring software,
- Flight tracking software, and
- Geographic information system (GIS).

Tools and who has access to the tools are described in Table 1.

How Performance Is Assessed

A series of questions were asked to determine how airports assessed their performance regarding their green initiatives. Of the 15 airports surveyed, all but one reported they assess the performance of their sustainability practices, and with only one exception, they evaluate their performance data for trends. The majority (12 airports) included cost savings in their performance data (Figure 7).
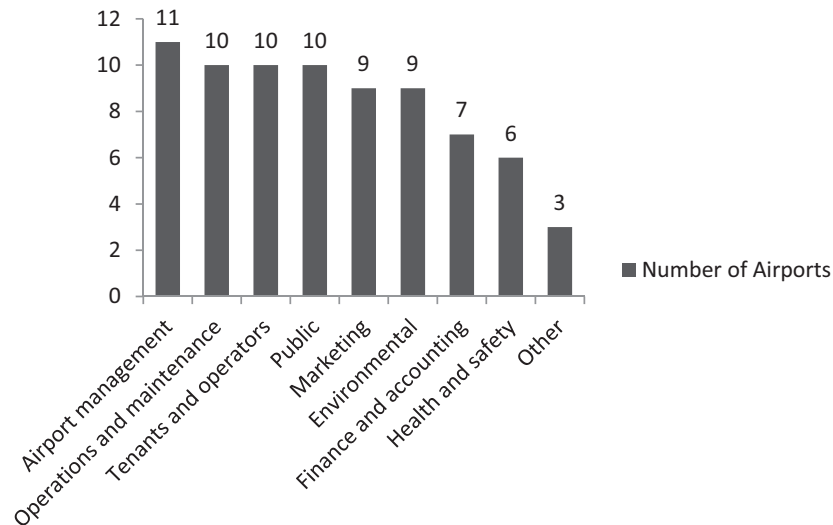
FIGURE 7 Reports of sustainability performance.
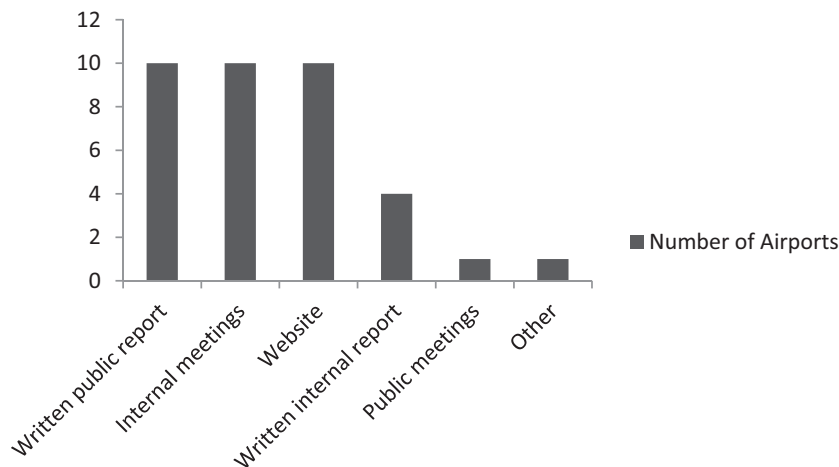
FIGURE 8 Methods used to report performance.

How Performance Is Reported

When the airports were queried about reporting of their sustainability performance, 12 responded that they did report on performance. Internally, almost all reported performance to airport management, with operations and maintenance following closely behind. Externally, most of the reporting airports reported performance to their tenants, operators, and the public (Figure 8).

Most airports report their practices through written public reports, internal meetings, and on their websites. Four of the airports provide written internal reports, and one provides the information at public meetings. One airport reports on its sustainability performance through presentations to industry stakeholders.

The 12 airports were then asked about the structure of their reporting. Four used the GRI reporting guidelines of which one had their report verified. Four reported using the ACI Airport Performance Measurement Guide.

POSITIVE OUTCOMES OF GREEN INITIATIVES

The airports were asked to rate various benefits they received from their green initiatives. Nine of the survey respondents reported that their airports obtained all of the positive outcomes included in the survey. The highest ranked benefit was improved sustainability performance. This benefit was followed by recognition of leadership in the industry and greater management confidence. Risk reduction, protection of environmentally sensitive receptors, improved compliance and regulator relationships, and improved tenant and customer relationships followed with similar rankings (Figure 9).
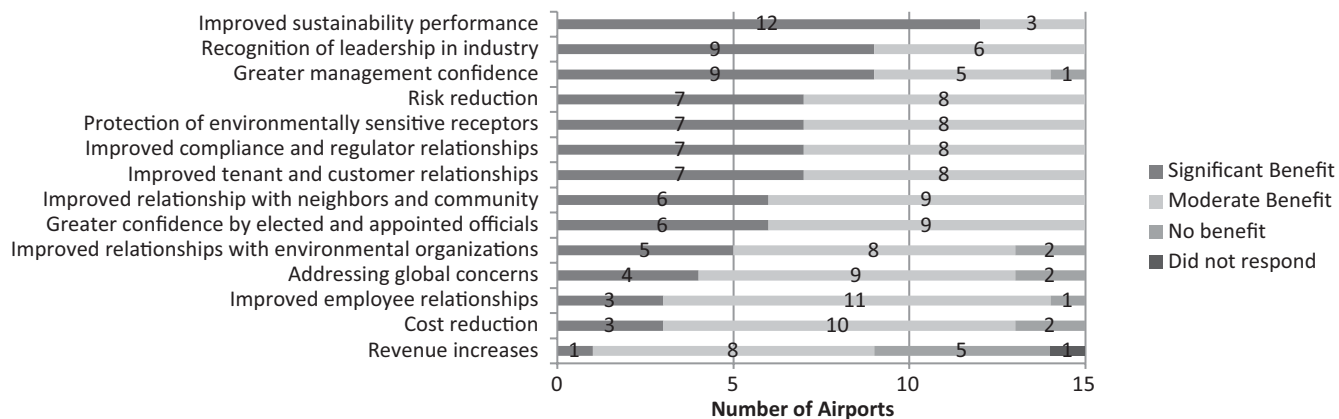
FIGURE 9 Benefits gained from green initiatives.

16
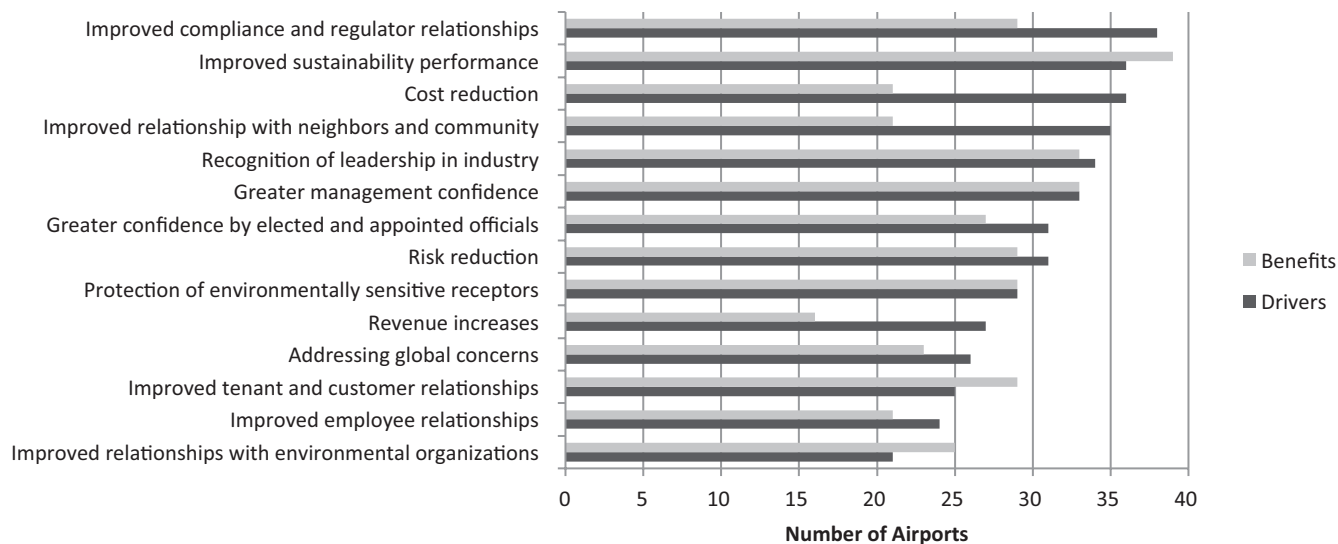
FIGURE 10 Positive outcomes compared to drivers.

When the positive outcomes gained from green initiatives were compared with the drivers, a moderate correlation was found ($r = 0.38$), indicating that the outcomes from green initiatives were somewhat reflective of the drivers for the initiatives but not entirely so. For example, although compliance was ranked as the most significant driver, the benefits of improved sustainable performance, recognition in the industry, and greater management confidence were all ranked higher as positive outcomes. The widest negative gaps between drivers and positive outcomes regarded cost reductions and improved neighbor and community relations. Positive outcomes that exceeded drivers included sustainability performance, improved customer and tenant relationships, and improved relationships with environmental organizations (Figure 10).

BARRIERS TO IMPLEMENTATION

Airports were asked to identify barriers to implementing their sustainability practices. The airports ranked insufficient resources or staff and competing priorities as their greatest barriers. These were followed by lack of top management support; however, three airport reported that this was not an issue for them. All three identified airport management as having a leadership role in their programs. Union resistance was ranked lowest as a barrier and was identified as not relevant by almost half the airports. The airports were also asked open-ended questions regarding barriers and how they overcame them. Airports that indicated their greatest barrier to success was insufficient resources or staff overcame the problem in a number of ways. One overcame limited funding by implementing a collaborative airport planning effort with the city and community. Another airport identified alternative financing mechanisms and ways to minimize staff time requirements. Another successfully used grants and collaboration with the city to overcome funding issues. One of the airports responded that top management support is essential for the smooth implementation of sustainability initiatives (Figure 11).

Buy-in across the organization was identified as a challenge that was successfully overcome by engaging employees to help develop and administer the various programs. Another found that stakeholder coordination could be improved by identifying stakeholders and including them early in the process.

IMPROVEMENTS

The 15 airports were asked, "What would you do differently in terms of your sustainability practices?" The majority of the answers focused on governance and process. Identified needs included a policy, a plan, and a budget. Appropriate organizational structure with access to top management was another area
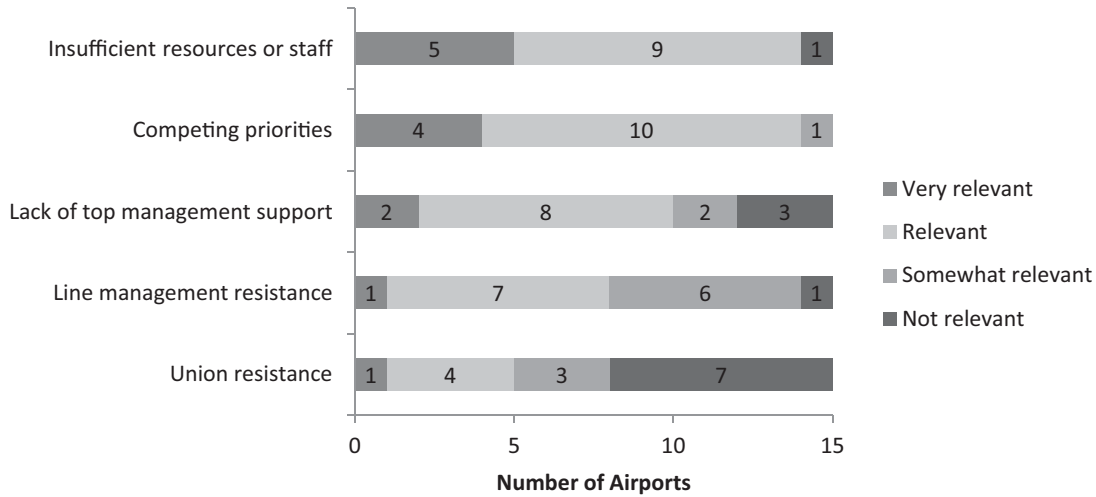
FIGURE 11 Barriers to implementing green initiatives.

of consensus for improvement. Finally, setting goals and monitoring performance was identified as an area for improvement.

SUCCESSES

The airports were asked "What has been your greatest success?" Many survey respondents pointed to the successful implementation of a particular practice. A few focused on successes with supporting processes and governance, such as training and communication. A few others focused on the recognition of their leadership resulting from the implementation of the practices.

FUTURE PLANS

The survey asked, "How do you hope to improve in your sustainability practices over the next five years?" All the airports have significant plans. Most responses focused on the development of processes and structure that will support sustainability practices, rather than plans for specific new initiatives. The respondents were considering how better to integrate sustainability into their operations.

18

CHAPTER SIX

GREEN PRACTICES WITH CASE EXAMPLES

To understand green initiatives, the survey queried airports about specifics of practices they had implemented. From this, potential case examples were identified that would provide an in-depth look at practices.

SURVEY RESULTS

Using GRI as a guide, categories for sustainable practices were consolidated, and the airports were asked to provide information regarding their specific practices that fell into those categories. The categories consisted of:

- Material purchasing and use;
- Green buildings;
- Green construction;
- Green transportation;
- Energy;
- Water resources, wastewater, and stormwater;
- Land use, biodiversity, wildlife management, and restoration;
- Air quality and greenhouse gas emissions;
- Waste and recycling;
- Noise;
- Adaptation to climate change; and
- Life-cycle assessment.

The airports were asked to identify as many as 10 sustainability practices. Airports could list more than one practice for each respective category.

For each practice, the airport identified:

- The practice category;
- Any goal associated with it;
- If it was monitored or measured, and how; and
- Benefits derived from the practice.

The 15 airports reported a total of 88 practices. Three airports listed 10 practices, so it is possible these airports have some additional practices that were not identified. One airport reported one practice. The median number of practices reported was six.

The most common practice area was in the category of waste and recycling, with all but two airports reporting practices in this area. The next most common practice categories were energy and water resources, wastewater, and stormwater. Practices in the categories of green transportation, air quality and greenhouse gases, and green buildings were the next most common, closely followed by green buildings and noise, with almost half the airports reporting practices in these categories. A summary of the practices is provided in Figure 12.

It can be noted that the practices are self-reported for this study and could reasonably fall under various categories, depending on the specific practice. For example, one airport identified its carbon
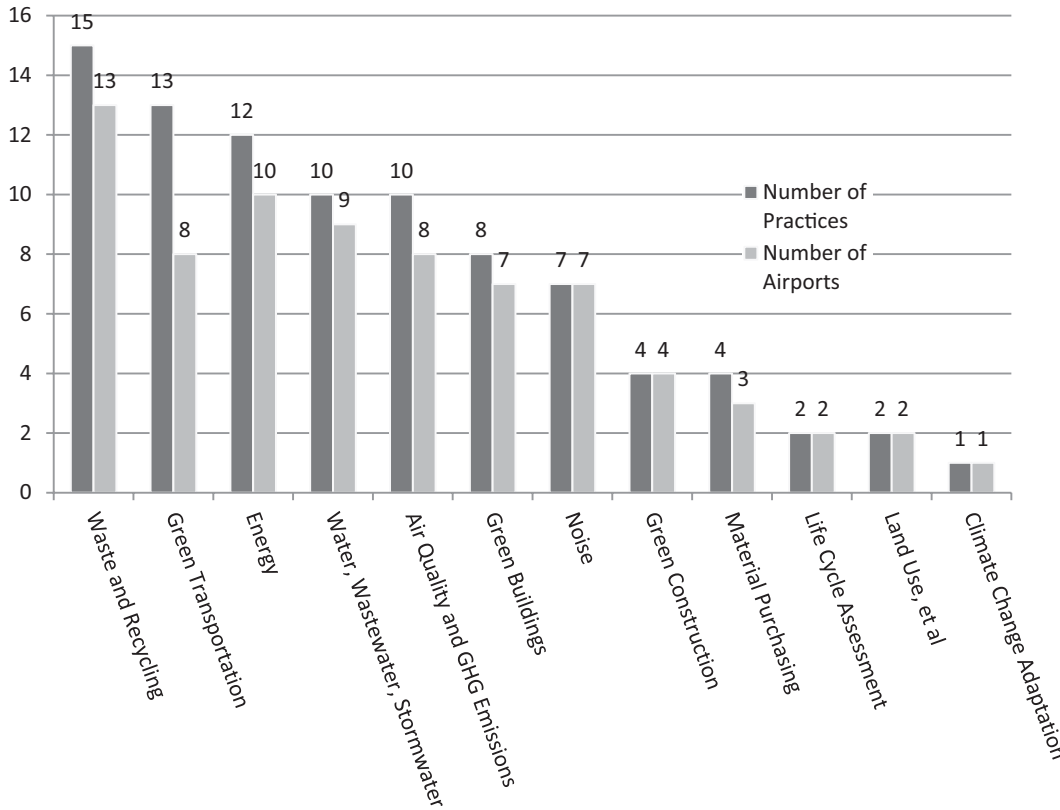
FIGURE 12 Green practices by category.

offset practice as Air Quality and GHG (greenhouse gas) Emissions; however, the initiative also falls into the energy efficiency category because an improved heating, ventilation, and air conditioning (HVAC) system was installed in the terminal.

The majority of practices (77 of 88) have goals associated with them that the airports have established, and 79 of the 88 practices are monitored or measured. The variables monitored and measured tended to fall into three categories in the following order: environmental performance, participation in a practice, or costs or revenues generated. In some cases, environmental performance measures were normalized, such as energy use per number of square feet. Less information was available on the cost of the initiatives. Cost data were not available for 69 of the 88 practices. The cost data that were provided ranged from $80,000 to $500 million, as would be expected given the range of types of practices. The lowest cost reported was for the installation of an electric vehicle (EV) charging station, and the most expensive was for a residential and school sound insulation installation program in the surrounding community.

Additional details of the airports' practices can be found in Appendix A.

CASE EXAMPLES

Case examples were selected from the practices reported. In making the selections, the synthesis team attempted to showcase the practices that the airports considered most significant while also providing a cross section of practice.

Although the case examples describe specific practices, they are written to illustrate lessons potentially applicable to other airports and provide a perspective applicable to the implementation of similar or other categories of practices. The case examples were developed from the in-depth interviews and supplemental material provided by the airport (Table 2).

20

TABLE 2
SUMMARY OF CASE STUDIES

Case Study	Practice Category	Airport
LEED Platinum Headquarters	Green buildings	Portland International Airport
Multimodal Transportation Approach	Green transportation	Boston Logan International Airport
Energy Efficiency That Pays for Itself	Energy	Newark Liberty International Airport
State-of-the-art Deicing Infrastructure	Stormwater	Denver International Airport
Addressing Climate Change and Selling Carbon Credits	Climate change	Montréal–Pierre Elliot Trudeau International Airport
A Public-Private Partnership Results in Reduced Greenhouse Gas Emissions	Green transportation	San Diego International Airport
Moving Toward a Community Goal of Zero Waste	Waste and recycling	San Francisco International Airport
Getting a New Practice off the Ground	Waste and recycling	Minneapolis–Saint Paul International Airport
Using Life-Cycle and Life-Cycle Cost Analysis Tools to Support Sustainable Practices	Green construction	Phoenix Sky Harbor Airport
Using the Global Reporting Initiative Framework	Green performance reporting	Hartsfield–Jackson Atlanta International Airport
Development of a Green Design and Construction Manual Leads to an Integrated Approach to Sustainability	Green buildings and construction	Chicago O'Hare International Airport
Applying Triple-Bottom-Line Thinking to Regional Development	Land use	Toronto Pearson International Airport

Source: First Environment, Inc.

Each case example includes a summary table of drivers, outcomes, and lessons learned. The drivers summarize the reasons for implementing a practice. The outcomes provide the results of the practice. In some cases these are performance metrics; in others the outcomes may be qualitative in nature. The lessons learned include the experience gained by the airports in implementing the practices. This may include such information as effective methods or unanticipated results.

GREEN BUILDINGS—LEED PLATINUM HEADQUARTERS: PORTLAND INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned

• Need to consolidate staff that were located in various offices in the city
• A commitment to regional sustainability
	• LEED Certified Platinum Headquarters demonstrated leadership and raised public awareness
	• 36% more energy efficient and 75% water savings compared with a typical office building
	• 78% more energy efficient than a typical garage
	• 100% of wastewater treated, with most reused on site
	• 84% to 86% of solid waste diverted through recycling and composting
		• The LEED Platinum building not only enhanced environmental performance but also led to:
		  – Increased environmental awareness of employees and the public,
		  – Greater staff involvement and participation in sustainability initiatives,
		  – Strengthened culture and collaboration while providing operational efficiencies.

The Context

The Port of Portland, which operates Portland International Airport (PDX), constructed a LEED platinum-certified headquarters building on the airport site to consolidate airport and other Port staff into one location. Before consolidation at the new building, staff were located in the downtown area and at various other Port locations. The design, construction, and operation of the building directly reflect the airport's commitment to triple-bottom-line sustainability, a commitment that reflects the region served by the airport (Figure 13).

LEED Platinum

In 2011, the headquarters building that sits on top of the PDX long-term parking garage and rental car facility was opened. The building showcases techniques for daylighting, green roofs, and conserving water, energy, and other natural resources. Construction included the use of businesses owned by women or minorities and/or small businesses, with 24% or $45.8 million in contracts going to 70 small businesses. Twenty percent of labor hours were performed by apprentices, 20% of whom were women or people of color. The building, including the offices and a parking structure with a rental car facility, is recognized as one of the world's most high-tech green buildings.

Heating and Cooling Systems

The project included an innovative heating and cooling system, which is the first of its kind in the United States. The fluid in the closed-loop system is heated or cooled by 200 underground pipes that are used for thermal heat exchange. The fluid is warmed or cooled based on its return temperature. The closed-loop system is attached to radiant heating and cooling panels in the building ceiling, providing heating or cooling to the ambient air, as required. The system is augmented with cooling towers that provide additional cooling capability in hot weather.
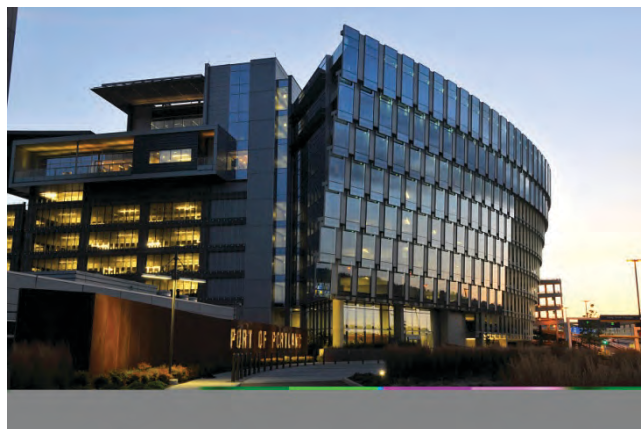
FIGURE 13 LEED platinum-certified Port headquarters.

22

Innovative Wastewater Treatment System

The building is equipped with an on-site wastewater treatment system that treats 100% of its wastewater, both gray and black water, for non-potable reuse in the building. The system, known as a Living Machine, produces quality recycled water without the chemicals, odor, other negative by-products, or high energy use required by conventional systems. The treated water is reused for toilet flushing.

The building's water treatment process can be seen in the first floor office lobby in a series of treatment cells topped with plants. Beneath the plant layer, the tank is filled with gravel. In these and additional planted gravel-filled tanks, the system accelerates natural water purification by employing a series of diverse ecologically engineered environments. Microorganisms and plants thrive by breaking down and digesting organic pollutants present in the wastewater. The treated water is finished with ultraviolet sterilization. The system, combined with water-efficient fixtures, has reduced water usage by 75% or approximately 360,000 gallons per year (Figure 14).

Daylighting

Atria lit by diffused-light skylights help to spread natural light throughout the office area. Narrow, open office floors with low divider walls also facilitate natural daylight and views while minimizing energy consumption used for lighting.

Parking Garage and Rental Car Return

The parking garage uses a parking guidance system that identifies the number of parking spaces available on each floor and lights the available spaces. This reduces the idling of vehicles in the garages and parking time. The airport has also installed charging stations to accommodate EVs, with six stalls for public use and another two stalls for the valet. Visitors pay the standard parking rate, but there is no fee to charge the vehicle.

Green Roofs

The building has two green roofs. The north-side, ninth-floor, 10,000-square-foot Eco-roof provides significant areas for rainwater treatment and creates a green surface that serves to filter stormwater, reduce the building's heat island effect, insulate the building, and provide a green amenity. The eighth and ninth floor landscape deck, green roof locations include an adaptive plant micromist irrigation system installed to establish the plants. The system is now used only in severely warm weather.

FIGURE 14 Living machine.

Materials and Finishes

The sustainable design for the headquarters building included low-VOC (volatile organic compound) paints and materials, building products with recycled content, and regionally manufactured materials. Where appropriate, existing furniture was repainted, refinished, or reupholstered for reuse in the building. Cobblestones in the entry plaza once served as ballast in ships. Reclaimed old-growth fir from the Port's marine Terminal 4 was used in the building entry lobby.

Waste Reduction and Recycling

The airport also implemented recycling and waste-reduction policies that have resulted in a diversion rate of 84% to 86% of solid waste. The building is equipped with centralized copying and printing facilities that use wax bars, rather than printer cartridges. Tree-free, recyclable sugar cane and bamboo paper is also used. When new employees complete their initial EMS training, they receive a durable cup for personal use as an individual incentive to minimize waste.

Financing

The overall building cost was $241 million, $156 million for the parking garage, pedestrian tunnels, and related utilities, and $85 million for the offices. The building was financed exclusively from available working capital, revenues from the cost center, and airport revenue bonds paid for by the Port cost center. No state or local tax funds were involved in the new structure. The Port cost center includes parking, rental car, air cargo, and other revenues collected at the airport.

Lessons Learned

Although the environmental performance of the LEED platinum building is an important achievement, the consolidation of staff has also enhanced environmental awareness and leadership and strengthened the sustainability culture at PDX and the Port. As a result, the staff is more engaged and regularly contributes ideas to improve environmental performance and triple-bottom-line sustainability.

Notable Achievements

In addition to the LEED platinum certification, the building has received the following awards:

- City of Portland Businesses for an Environmentally Sustainable Tomorrow Green Building Award;
- State of Oregon Sustainability Award;
- Northwest Energy Efficiency Alliance Better Bricks Award;
- Environmental Protection Agency Green Power Leadership Award;
- Forbes Top Ten Most High-Tech Green Buildings in the World; and
- Sustainability at Work—Gold Certification, Headquarters Building (City of Portland Bureau of Planning and Sustainability), 2013.

> A micromist irrigation system is a low-flow irrigation system that distributes irrigation water slowly in small volumes with little runoff. It is included in the LEED rating system.

For more information on PDX's LEED-certified building, see http://www.portofportland.com/prj_POP_HQP2_Home.aspx.

For a copy of the airport's sustainability report, see http://www.pdxairportfutures.com/Documents/PDX_AF_Sust_rpt.pdf.

24

GREEN TRANSPORTATION—A MULTIMODAL TRANSPORTATION APPROACH: BOSTON LOGAN INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• Proximity of Logan to the city of Boston • Potential impact of airport-related ground transit on surrounding neighbors	• 75% reduction in shuttle bus fleet, reduced congestion, and decreased emissions with consolidated rental facility • Reduced traffic and emissions in surrounding neighborhoods and additional revenue from the leased on-site Green Bus Depot • Increased employee use of mass transit with discounted transit passes • Reduced air emissions through incentives for alternative fuel vehicles for shuttles and taxicabs	• Capitalize on sustainability practices that can also provide a source of revenue • Use incentives creatively to encourage participation • Combine practices to achieve sustainability goals.

The Context

The most mature sustainability efforts at Boston Logan International Airport (BOS) are its ground transportation practices. The proximity of the airport to the city of Boston, with its extensive mass transit system that can be harnessed, and the impacts on surrounding neighborhoods of ground transport associated with airport activities have been the main drivers for this set of practices.

A Multimodal Approach

Taking a comprehensive multimodal approach to this issue, BOS has reduced transportation costs and improved customer service for passengers, employees, and other airport users with their Consolidated Rental Car Facility, on-premises Green Bus Depot (LEED Silver), incentives for employees to use mass transit, and incentives for alternative fuel vehicles.

Consolidated Rental Car Facility

The new Consolidated Rental Car Facility is opening in the fall of 2013. The facility is on the premises of the airport and is reachable via a consolidated fleet of shuttle buses, which replace individual diesel buses operated by each rental agency. This results in a nearly 75% reduction in the shuttle bus fleet, reducing the total number from 98 to 26. In addition to reducing the number of shuttle buses and resulting congestion, the airport will benefit from an additional decrease in air emissions because the 20-year-old compressed natural gas (CNG) fleet is being replaced with hybrid buses.

LEED Bus Depot

The Green Bus Depot that maintains the new fleet of buses is LEED silver certified. It is the largest clean fuel bus facility in the region. Located at the airport, it reduces bus traffic and corresponding emissions to the surrounding neighborhoods. The Green Depot is leased to an operator and creates a source of revenue for the airport.

Discounted Mass Transit

The airport, in partnership with MassRIDES, a program of the Massachusetts Department of Transportation to promote green transportation options, set up the Logan Airport Transportation Management Association (Logan TMA). Logan TMA members include the airport and its tenants. Through the TMA, employees of its 23 member organizations are provided information and support on transportation options. Employees who use mass transit are provided discounted monthly passes on public transportation. This has resulted in increased use of Massachusetts Bay Transportation Authority public transit and waterway transportation and decreased use of private vehicles.

Incentives for Alternative Fuel Vehicles

BOS has been providing incentives to encourage the use of alternative fuel vehicles. Hotel shuttles receive a discounted fee if they use alternative fuel vehicles. Alternative fuel taxi cabs, which consist mostly of hybrids, receive priority in line to pick up passengers twice per shift. BOS also provides EV charging stations at garages and parking lots.

Notable Achievements

The benefits of their ground transportation initiatives include:

- decreased emissions;
- decreased operational and maintenance costs;
- decreased traffic in the surrounding neighborhoods; and
- increased revenue—providing a source of revenue for the airport.

ENERGY—ENERGY EFFICIENCY THAT PAYS FOR ITSELF: NEWARK LIBERTY INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• Participation in the energy conservation program of the Port Authority of New York & New Jersey (PANYNJ) • A goal to reduce contribution to climate change, air pollution, and depletion of the ozone layer • A target to reduce electrical usage by 10% by 2015	• More than $10 million in projects funded through energy savings • Expectation of $1 million in annual savings, a payback period of 9.5 years for energy service company (ESCO) projects • Combined with the completed chiller retrofit project, the airport is $1.5 million in annual energy savings	• Consider using alternative financing models to achieve improvements in energy efficiency • Use a combination of internal knowledge and external expertise to identify opportunities.

The Context

Newark Liberty International Airport (EWR) is operated by PANYNJ. Consistent with agency-wide sustainability policy, EWR participates in the PANYNJ's sustainability initiatives, including its energy conservation program. In meeting the airport's commitment to energy conservation, EWR has focused on implementing airport energy projects that can pay for themselves through the savings in energy.

Setting Goals and Targets

As part of its many sustainability initiatives, EWR set a goal to minimize the airport's contribution to climate change, air pollution, and depletion of the ozone layer. One associated target is to reduce electrical utility usage (compared to the 2009 baseline) by 10% by 2015. To evaluate progress against established targets, the airport regularly monitors and reports energy consumption.

Meeting Targets and Goals Through Energy Efficiency

EWR's energy efficiency program is an important contributor to meeting the goal. Approved energy projects include lighting retrofits, chiller replacements, improved building insulation and controls, and renewable energy installations. The current phase of the program is expected to be completed in 2014, and EWR staff hope to continue identifying additional projects for future phases of the program. An example of a completed project under this program is the Newark Airport Central Heating and Refrigeration Plant chiller and lighting replacement project. In 2010, the local utility provided an 80% incentive for a $6.2 million project scope that was estimated to achieve $579,760 in annual energy and maintenance savings. Under this utility-sponsored program, the PANYNJ was responsible for only 20%, or $1.24 million, of the total project cost.

Combining Internal Knowledge and Outside Expertise to Meet the Goal

To further the airport's energy efficiency effort, EWR staff also decided to enter into a partnership with an ESCO. With the ESCO, EWR initiated a process to identify and screen potential energy projects using a combination of internal knowledge and external expertise. EWR's facility electrical staff and senior management collaborated with an ESCO to identify potential energy conservation projects. Once identified, the ESCO performed investment grade audits (IGA) on the potential projects and identified the guaranteed energy savings and return on investment (ROI). Projects with positive ROI were then considered to be candidates (Figure 15).

> An **ESCO, or energy service company**, is an organization that develops, installs, and arranges financing for projects designed to improve energy efficiency. ESCOs assume the technical and performance risk associated with the projects.

Financing Sustainability

The PANYNJ Multi-Facility Guaranteed Energy Savings Program (an ESCO program) provided the mechanism for funding of EWR's $10.4 million effort through an energy performance contract. The contract required no capital investment by the airport. Instead the airport funded the projects through

Electricians working on Terminal B cans

New fixture vs old fixture

FIGURE 15 EWR photos. (*Source:* EWR)

its operating budget, and savings attributed to reduced energy consumption are being used to repay the project's principle.

The airport and the ESCO agreed on a monitoring and verification plan for the verification of guaranteed energy consumption reductions based on the U.S. Department of Energy–established International Performance Measurement and Verification Protocol.

> An **energy performance contract** is a financing technique that uses the cost savings from energy efficiency projects to finance the project itself. The ESCO provides the initial capital and designs, constructs, maintains, and monitors the project in return for a set fee (usually monthly) paid to the ESCO by the facility operator. The fee is offset by the reduction in energy costs associated with the improved energy efficiency.

Involvement of Tenants and Concessionaires

Tenants and concessionaires have not been included in the energy efficiency practices. However, EWR has provided communications and held workshops to encourage tenants to implement similar sustainable practices.

Notable Achievements

EWR expects to achieve $1 million in annual savings from the ESCO project, which has a payback period of approximately 9.5 years. Combined with the previously completed Newark Airport Central Heating and Refrigeration Plant project, the airport is now realizing more than $1.5 million in annual energy savings against a 2009 baseline.

For information on the EWR sustainable management plan, see http://www.panynj.gov/about/pdf/newark-liberty-sustainable-management-plan.pdf.

STORMWATER—STATE-OF-THE-ART DEICING INFRASTRUCTURE: DENVER INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• Airport built with focus on environmental protection	• Collection system captures 69% of deicing fluid applied, of which 45% to 50% is recycled as glycol, 3% is in recycling sludge that is sent to the landfill, and 47% is sent to a wastewater treatment facility • Denver International Airport (DEN) saves about $1 million per year in disposal costs because glycol is recovered	• The original design required modifications to equipment and deicing locations • The airport continues to improve the system to better meet the airport's and its customers' needs.

The Context

One of Denver International Airport's (DEN) landmark sustainability practices is its state-of-the-art deicing facilities, which include dedicated deicing pads; tiered deicing fluid and stormwater collection, conveyance, and storage; and an on-site propylene glycol (glycol) recovery facility. The deicing facility dates to the initial development of DEN, as does the airport's commitment to sustainability. DEN was conceived and built with environmental protection in mind.

FIGURE 16 Deicing at DEN.

A Centralized Approach to Deicing

The centralized deicing infrastructure includes seven dedicated deicing pads that cover more than 36 acres at the airport. The pads are used to deice almost all aircraft that use DEN. Limited use of deicing fluid (as much as 25 gallons, undiluted) is permitted at the gate to allow aircraft to taxi to the central deicing pads. The pads are elevated and surrounded by slot drains and piping so that deicing fluid is gravity-fed to a glycol recovery facility—eliminating the need for lift stations (Figure 16).

A second-tier stormwater collection system services an additional 61% of the airport, including the ramps, aprons, runways, and other locations that may be affected by deicing fluids from aircraft movement. The system allows stormwater contaminated with glycol to be diverted to city-owned stormwater retention ponds for disposal at a wastewater treatment plant.

Additional deicing is allowed on two smaller pads that are serviced by a mobile deicing fluid recovery vehicle—a glycol recovery vehicle. The pads are equipped with valves that can be closed to prevent stormwater from entering collection basins when deicing is taking place. During deicing events, a deicing fluid recovery vehicle vacuums the fluid as it collects.

One of the pads services a commuter airline with approximately 100 flights per day on smaller turbo prop aircraft. Deicing typically requires no more than 25 gallons of Type 1 deicing fluid. Cargo and private/charter aircraft also deice using the ramps at the south cargo and general aviation facilities, respectively. Use of these pads allows the other deicing pads to focus on passenger traffic.

The vacuumed fluids are then transported by the fluid recovery vehicle directly to the on-site glycol recovery facility.

In addition to glycol recycling, a benefit of numerous deicing positions is the decrease in emissions from airplanes idling while waiting to be deiced. This also results in cost savings for the airlines from the reduced fuel consumption.

State-of-the-Art Recycling

The glycol recovery system at DEN is run by an independent contractor who operates and maintains the facility on behalf of the airport and owns the glycol product that is produced at the recovery facility. The contractor also provides and operates the mobile deicing fluid recovery vehicle. The contractor has provided proprietary mechanical vapor compression units (MVRs), which use a high-efficiency distillation process to concentrate deicing fluids with levels of glycol at or above 1%. Any fluids received at the recovery facility with lower concentrations are routed to the stormwater retention basin for disposal at the wastewater treatment facility. The MVRs concentrate the deicing fluids to approximately 40% glycol. The concentrated fluids then flow through a one-stage vacuum distil-

lation unit and are further concentrated to 99%+. The fluids then flow through an industrial deionization unit and carbon polishing. The glycol is resold by the contractor on the market for other uses.

Lessons Learned

Since the installation of the deicing facilities when the airport was constructed, substantial modifications have been made to the system to address challenges that have been encountered. The initial deicing pads were constructed predominantly on the west side of the airport, with an east-west orientation. The orientation was at odds with the northerly prevailing winds, which made fluid application more difficult than necessary. As a result, airport officials determined that future deicing facilities would be constructed with a north-south orientation, thus improving the fluid application process.

The original glycol recovery plant included only the one-stage vapor distillation unit, which was designed to treat fluids at concentrations greater than 8%, but in practice, these units had difficulty with fluids containing concentrations of glycol below 12%. The addition of the MVRs was critical to overcoming this limitation.

Another issue is that although gravity flow eliminates the need to pump fluids, it also results in a buildup of sediments at the glycol recovery facility, which then requires additional maintenance.

Notable Achievements

The collection system at the airport now captures, on average, 69% of the deicing fluids applied. Of this amount, 45% to 50% is recycled as glycol, 3% is in the recycling sludge that is sent to the landfill, and the remaining 47% is sent to the wastewater treatment facility. The cost for fluid recovery is also substantially lower than the cost of wastewater treatment. If the glycol recovered were instead sent to the wastewater treatment plant, the cost for treatment would add approximately $1 million to the cost. The glycol recovery system at DEN protects the environment, reduces waste, and saves money.

For more information on DEN's sustainability practices, see http://business.flydenver.com/community/masterplan/faqs.asp.

CLIMATE CHANGE—ADDRESSING CLIMATE CHANGE AND SELLING CARBON CREDITS: MONTRÉAL–PIERRE ELLIOT TRUDEAU INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• A terminal expansion provided opportunity to pursue energy efficiency and cost savings with a new power plant • In 2007, Montréal–Pierre Elliot Trudeau International Airport (YUL) began tracking its GHG inventory and addressing climate change	• Raised net efficiency to 86% and reduced heating energy consumption by 50% to 60% with use of high-performance gas boilers augmented with heat recovery • Sold 23,000 carbon offset credits for the period 2003–2009 for Can$115,000—becoming first airport in North America to sell to the carbon market • Received 2007 ASHRAE Technology Award	• Airport projects can provide an opportunity to implement sustainability practices • Energy efficiency provides an opportunity to reduce GHG emissions and potentially provide revenue.

FIGURE 17 New power plant.

The Context

In 2003, as one of Montréal-Pierre Elliott Trudeau International Airport's (YUL), or Aéroports de Montréal's, initial sustainability practices, the airport constructed a new Can$15,000,000 energy-efficient power plant. The airport took advantage of the opportunity to construct the plant when it undertook a major reconstruction of the terminal. Five years later, staff realized the airport could potentially capitalize on the reduction in GHGs associated with the energy-efficient plant and sell credits in the carbon market as well.

Taking Advantage of an Airport Expansion

During the terminal expansion, a new power plant was located closer to the terminal to minimize energy losses. Locating the plant near the terminal required that emissions be modeled to ensure no interference with the control tower. High-performance gas boilers with an 81% operating efficiency replaced the old oil-fueled boilers. Moreover, heat recovered from gas boilers' exhaust and chillers' condensers is transferred by means of heat exchangers to the low-temperature hot water circuit. This increases the boilers' net efficiency to 86% and reduces the energy consumed for heating by 50% to 60% (Figure 17).

Continuing to Improve

YUL continues to identify opportunities to minimize energy consumption and GHG emissions. Since construction of the plant, the airport improved the operation of the plant and conserved additional energy by optimizing the control sequences of existing equipment.

Developing a Baseline Inventory

In 2007, YUL began tracking its GHG inventory as part of the airport's sustainability commitments. The yearly inventory includes Scope 1 emissions associated with airport operations and

GHG Inventory Emissions:

Scope 1—a reporting entities direct GHG emissions.
Scope 2—indirect emissions associated with a reporting entity's purchased energy.
Scope 3—third-party non-energy emissions that are a result of the reporting entity's operations, but not generated by the reporting entity.

Scope 2 emissions associated with the electricity airport operations consume. The Scope 1 and 2 emissions inventories identified that more than 40% of the airport's emissions were associated with HVAC.

In addition, the airport calculated its Scope 3 emissions in 2007. Included in its Scope 3 emissions are aircraft activity in airport area; airline and other tenant vehicles, ground service equipment (GSE), and electricity usage; and ground access vehicles for staff and passengers, including buses and taxis.

The Scope 1 and 2 inventories are calculated every year, but the Scope 3 emissions will be calculated every 10 years. However, the airport authority is considering using ACI's Airport Carbon and Emissions Reporting Tool (ACERT), which is a self-contained Excel spreadsheet that enables an airport operator to calculate the airport's GHG emissions. In that case, the airport authority will calculate Scope 3 using the software.

Setting Targets

Using the 2009 GHG inventory as a baseline, the airport set reduction targets on energy and GHG emissions of 20% by 2015 for HVAC emissions. This target is normalized by square footage of space serviced and degree days.

Discovering an Unexpected Source of Revenue

Before developing the airport GHG inventory and setting reduction targets, the airport had made a substantial reduction in GHG emissions with the new power plant, although GHG reductions had not been the driver at the time. In 2008, airport staff realized the power plant might be eligible for carbon credits even though it was constructed before their focus on GHG emissions. Airport staff hired a consulting firm to help determine if the power plant energy reduction was an eligible project; if it met the criteria of additionality; and if it were an economically viable project, considering administrative and verification costs. They determined that the project was eligible. The technology in the power plant was significantly more efficient than the general level of technology, which meant it could pass the additionality test, and the potential revenue far exceeded the costs associated with obtaining the credits. The credits were then quantified for the period 2003–2009, and 23,000 credits were generated, verified, and registered with the Canada Standards Association. When sold for Can$5 per credit, they generated revenues of Can$115,000. The airport is currently quantifying and verifying credits for the period 2010–2012, estimating that approximately 18,000 credits will be generated, which reflects the further improvements made in the airport's power plant efficiency. At the prices received during the last sale, the airport could generate as much as Can$90,000 in additional revenues.

The airport has held down administrative and transaction costs associated with the credit sale by using multiyear reporting periods. In the future, the fuel switching from natural gas to electricity during off-peak hours has the potential to generate additional credits. As the general level of technology rises, the airport could potentially become ineligible for credits for this project, but in the interim the credits continue to generate revenue.

Notable Achievements

In addition to the fuel savings generated by the increased efficiency of the power plant and the revenue generated through the sale of carbon credits, the power plant project won first place in the 2007 ASHRAE Technology Awards. The airport has also gained public recognition as the first North American airport to sell carbon credits on the carbon market.

For more information on YUL's sustainability practices, see http://admtl.com/AboutUs/Environment/AeroEco.aspx and http://www.csaregistries.ca/cleanProjects/masterprojectdetails.e.cfm?pid=217.

32

GREEN TRANSPORTATION—A PUBLIC-PRIVATE PARTNERSHIP RESULTS IN REDUCED GREENHOUSE GAS EMISSIONS: SAN DIEGO INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• 20-year master plan • Agreement with California's attorney general to address GHG emissions in all future developments • Air quality management plan that included vehicle conversion program for ground transportation landside	• Close to 50% of taxis that service airport converted to Prius hybrids • Converted cabs reduced fuel and maintenance costs by $12,000 to $15,000 per year • Vehicle conversions saved 618,000 metric tons of carbon emissions per year • Customers have preference for green cabs	• Public-private partnerships can be very successful • Fee-based/tariff approach was not as successful as expected • Airports can have positive community impacts on sustainability that reach beyond their operations.

The Context

In 2008, San Diego International Airport (SAN) entered into an agreement with California's state attorney general (AG) to address GHG emissions in all future airport development. The agreement was an outcome of the airport's new 20-year airport master plan. As part of the agreement, the state committed to not challenge or intervene against the adequacy of the environmental impact report for the master plan.

The master plan includes additional gates, overnight jet parking, an expanded taxiway, and a 5,000-space parking structure. The master plan also identifies potential environmental effects through 2030 that include GHG emissions.

Working with local, regional, and state officials, SAN developed an air quality management plan. Part of the plan included an airport vehicle conversion program for ground transportation landside. Within the plan, the airport committed that the fleet of taxis, shuttles, and convenience vans that serviced the airport would meet the California low-carbon fuel standard by 2017. The low-carbon fuel standard requires a reduction of at least 10% in the carbon intensity of California's transportation fuels by 2020.

Initial Fee-Based Approach Does Not Bring About Sufficient Change

SAN's first approach to converting the fleets—a fee-based approach—was not as successful as expected. The approach provided for increasing permit fees for noncompliant vehicles, while reducing those fees for compliant vehicles meeting the state of California's low-carbon fuel standard. The fee increased every year to a maximum of 200%. Although it was expected to make a difference, the expected rate of conversion did not occur.

Public-Private Partnership

In 2011, SAN launched a new program that involved a public-private partnership approach. The partners included the SAN; the California Center for Sustainable Energy (CCSE), a nonprofit organization dedicated to creating change for a clean energy future; Mossy Toyota; and the San Diego Metropolitan Transit System. CCSE provided a $1 million sustainable energy grant from the state of California Reformulated Gasoline Settlement Fund. The grant provided $750,000 for rebates for vehicle conversion—to $7,500 per vehicle—with $200,000 of that earmarked for green taxis (Figure 18).

FIGURE 18 "Green" cabs.

SAN identified which vehicles were eligible for the program, focusing on decreasing carbon emission, fuel costs, and dependence on imported oil. Mossy Toyota provided an incentive to convert the former low-fuel economy taxicabs to the Prius V, offering financing packages and discounted maintenance plans. SAN also worked with the City's permitting agency that administers medallions to streamline the permitting process. The partnership provided outreach to the cabs, providing a needed understanding of hybrid technology. The airport also promoted the program by making regular public service announcements in the terminal encouraging passengers to use green cabs.

A Successful Outcome

After 9 months of the program, almost 50% of the taxicabs were converted to Prius hybrids. The drivers found that they reduced their fuel and maintenance costs by $12,000 to $15,000 per vehicle year and saved 350,000 gallons of gasoline. By September 2012, the fund had run out; however, taxicabs continue to convert because of the economic benefits.

SAN has also found that the passengers have a preference for the Prius cab, and Prius cabs are now found all over San Diego because of the positive impact that originated from SAN's program. Mossy Toyota is now the second largest Prius dealer in Southern California.

Next Steps

SAN continues to institute green transportation initiatives. Landside, they are building a consolidated rental car facility; airside, they are implementing some of the lessons learned from the landside vehicle conversion. They are looking to institute green purchasing decisions beyond those in place by the city, which owns the airport. SAN is also changing the perception that sustainability is the responsibility only of the environmental department.

Notable Achievements

The SAN vehicle conversion program has reduced CO_2 emissions by 618,000 metric tons per year. SAN's green taxi program has received awards from the Air Pollution Control District and an industrial environmental association. Equally important, the airport has found that public-private partnerships are an effective methodology for harnessing the strengths of many types of organizations and bringing them together for a common goal.

For more information on this program, see http://energycenter.org/programs/san-diego-airport-clean-vehicle. For SAN's sustainability report for the period 2011–2012, see http://sustain.san.org.

WASTE AND RECYCLING—MOVING TOWARD A COMMUNITY GOAL OF ZERO WASTE: SAN FRANCISCO INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• California law requires a minimum 50% recycling of municipal solid waste • San Francisco City and County require 75% recycling of combined municipal and construction/demolition waste by all city departments and achievement of zero waste by 2020	• In fiscal year 2012, San Francisco International Airport (SFO) diverted 35% of the total annual waste of 10,239 tons to composting and achieved an overall recycling rate of 78% • Construction and demolition waste recycling rate was greater than 90% in the same period • Recycling of noncompostable materials provides a source of revenues	• At elevated recycling levels, incremental increases are harder to achieve—source separation becomes the key • Continued training of staff is needed to ensure source separation and proper waste handling • Tableware, bottles, and food containers advertised as compostable may not be biodegradable at particular composting facilities.

The Context

The California Integrated Waste Management Act of 1989 mandated a new approach to waste management with a focus on diversion and recycling with safe disposal only for that which could not be otherwise diverted. The Act set aggressive goals for diversion and initiated a new era in addressing waste. In 2002, to maximize sustainable uses of natural resources and eliminate solid waste generation, the San Francisco Board of Supervisors passed a Zero Waste Goal that requires the city to achieve zero waste by 2020. Meeting these community and state commitments has resulted in SFO developing one of the largest recycling and composting programs in San Mateo County.

Solid Waste at SFO

SFO generated 10,239 tons of general solid waste in fiscal year 2012. This waste material was generated by about 43,000,000 passengers traveling through the airport and by SFO employees and enterprises at the airport using the SFO solid waste management services (Figure 19).

SFO's solid waste management practices include source separation of recyclable materials, such as compostable waste, cardboard, paper, metals, and glass. These materials are hauled to composting and recycling operations by an outside contractor. The balance of the solid waste is transported to the waste separation facilities of the same contractor, where the mixed waste materials are sorted for collection of additional recyclable materials.

Starting with Source Separation

The first step SFO took to achieve waste reduction was to focus on source separation in airport operations. For more than 10 years within the terminals, the airport has provided designated containers for bottles and cans, paper, and solid waste. Three receptacles are provided together to make it easy for passengers and others to separate their waste at a single location. The airport attributes much of their success in this effort to the colocation of the different receptacles.
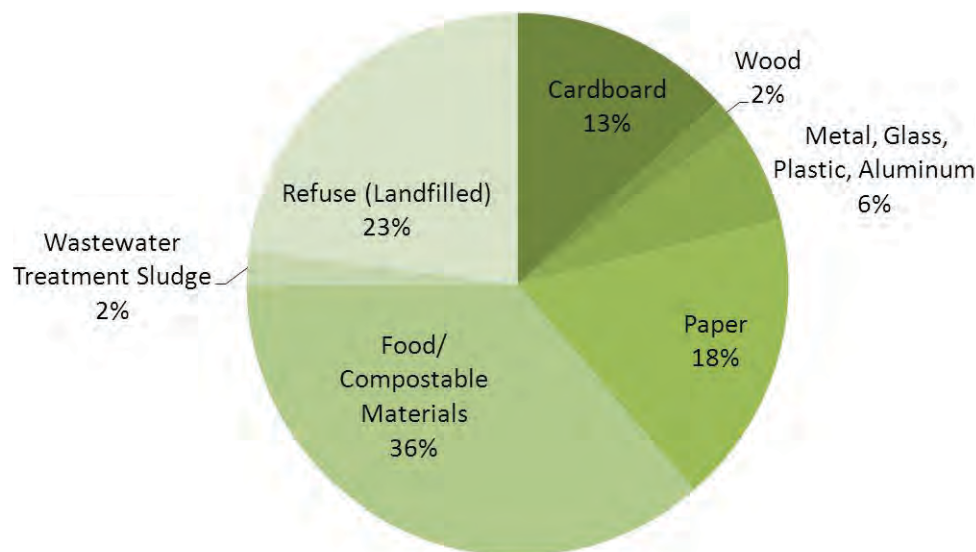
FIGURE 19 SFO solid waste.

Another important component is that airport custodial staff is trained and corrects any obvious errors.

The separated waste streams are consolidated in on-site dumpsters and compactors that are hauled to a nearby off-site material recovery facility. The nearby facility is another key component in SFO's success, and its presence is made possible not just the by commitments at the airport but also by the larger communitywide commitment to recycling.

At the off-site facility, mixed recyclables are sorted and any residual solid waste goes to a landfill. Recycled material includes paper and cardboard, plastics, glass, and metal. The majority of airlines deposit the waste generated onboard airplanes into compactors and bins supplied by SFO. The rate of source separation onboard the aircraft varies, depending on the policies and practices of various airlines. Some airlines use the services of an independent contractor to collect and handle their solid waste at SFO.

> **Sustainable Waste Practices**
>
> SFO is focused on:
> • Reducing material use and waste generation
> • Separating and diverting waste for recycling
> • Composting organics and
> • Recycling construction and demolition waste.

Composting of Food Waste and Other Biodegradable Waste Materials

SFO started a pilot food waste separation program in 2006; over the years, it has been transformed into an ongoing, large-scale composting program. At present, the airport transports all food waste, biodegradable materials, and landscaping trimmings (which made up more than one-third of the airport's waste stream) to an off-site composting facility. In all new leases and lease renewals, SFO has been requiring food vendors to use biodegradable tableware, plates, containers, and such, enabling the composting of 100% of the waste generated by food concessionaires. However, this policy is under review because the compostable tableware, bottles, food containers, and such do not biodegrade in the existing municipal composting facilities and are screened from the final composting product for disposal in a landfill. In addition, compostable bottles and food containers, when deposited in the general recycling bins, pose the additional hazard of contaminating the regular plastic waste materials and rendering those materials nonrecyclable.

The off-site facility composts approximately 78% of the material it receives from SFO. Some of the composted material is reused at the airport in its landscaping operations. Composting has contributed significantly to the increase in SFO's overall solid waste recycling rate.

36

Construction and Demolition Waste Recycling

Part of the source separation effort at the airport focuses on recycling of construction and demolition waste. The city of San Francisco requires recycling of a minimum of 65% of nonhazardous construction and demolition waste generated at city construction projects. SFO's internal goal is set higher at 75%. The airport has been consistently surpassing even this goal, with recycling rates of more than 90%.

Source Reduction

In addition to focusing on diversion, the airport recognizes that the reduction of potential waste is an important component of waste reduction. For example, the airport was included in a mayoral executive directive to reduce paper use. The airport programmed all printers and copiers to produce double-sided prints or copies and posted signs at all copying machines encouraging people to save paper and avoid unnecessary copying and printing. SFO also encourages staff to transmit documents electronically. These efforts resulted in 50% reduction in paper use at SFO.

In another initiative, airport staff identified a way to decrease the waste generated from the single-use plastic bottles that were being discarded at security screenings. To address this, SFO installed hydration stations in all boarding areas to give passengers a convenient way to refill personal water bottles after passing through security.

Cost Savings

SFO does not incur any cost for transport and handling of recyclable materials, such as glass, plastics, cardboard, metal, paper, and so forth. SFO also receives a credit for recycled metals and cardboard. However, SFO pays the same fees for the material it sends for composting as for landfilled waste.

Continuing Communication and Training

SFO has recognized that a successful practice requires continuing education and communication with the airport staff, tenants, and the general public. The airport has established an ongoing resource conservation program to increase awareness and educate, encourage, and persuade stakeholders to generate less waste.

Monitoring of Performance for Improvement

SFO understands that feedback on performance is critical to evaluating and improving performance. It relies on annual waste characterization studies and quarterly reports from the material recovery and composting facilities to evaluate performance and identify areas of potential improvement.

Continual Improvement

The airport is willing to try new approaches to improve its performance. However, at the high waste diversion rates currently achieved, improvements become more challenging to achieve. SFO is currently experimenting with eliminating trash receptacles in the food court of one of its terminals because the food vendors are providing only compostable supplies to customers. The airport is also considering improving its three-receptacle waste cabinets by adding openings that resemble the shape of the material deposited in these bins to provide visual cues as to what should be placed in each bin. Another challenge has been the handling of thin-film plastic bags. This problem was partially resolved after San Mateo County, where SFO is geographically located, enacted an ordinance requiring all vendors to use paper bags for carrying items sold to their customers. In looking for additional improvements, SFO staff recognize that enhanced source separation of recyclable materi-
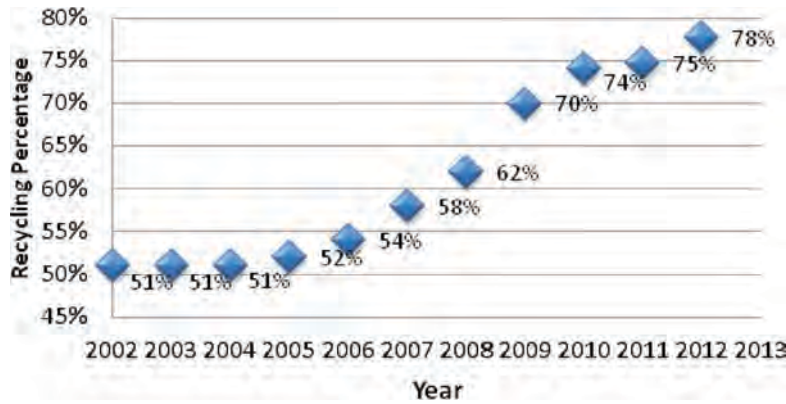
FIGURE 20 Historical airport solid waste recycling rate.

als, including separation in aircraft cabins, is key. SFO staff recognize there is a need for additional improvement of the off-site separation operations.

Notable Achievements

SFO has increased its solid waste recycling rate from 51% in 2002 to 78% in 2012, bringing the airport very close to achieving its interim goal of recycling 80% of its solid waste by 2015. In fiscal year 2012, SFO's recycling efforts generated almost 36% compostable materials and 43% other recyclable materials. With a goal of 90% to 92% recycling by 2020, SFO is nearing its goal; it has already reached the recycling goal for construction and demolition debris (Figure 20).

For more information on SFO's sustainability and waste management, see www.flysfo.com/sustainability.

WASTE AND RECYCLING—GETTING A NEW PRACTICE OFF THE GROUND: MINNEAPOLIS–SAINT PAUL INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• Expectations of the community • Identification of an unrecognized opportunity	• Two-thirds of solid waste has been diverted to recycling or composting • Each month, 25 to 30 tons of organic wastes are composted	• Build on practices established in the community • Start with a pilot • Use continual training to overcome high staff turnover at food establishments • Empower frontline custodial staff to oversee implementation.

The Context

In 2009, the Minneapolis–Saint Paul International Airport (MSP) recognized that it had an opportunity to reduce the amount of food/organic waste entering the solid waste stream from airport operations. With a grant from the county, MSP started its organics recycling program with a pilot program for back-of-house organic waste composting. In doing so, MSP drew on well-established recycling and composting practices in the community of Minneapolis at large. Composting of organics is common practice in restaurants, school districts, private companies, and stadiums. Taxes on solid

waste (17% statewide and 14.5% locally) have reinforced this participation by making it financially attractive to divert organics from the waste stream and the landfill.

Taking it Step by Step

MSP staff first conducted a food concession inventory to identify and better understand opportunities to capture organics for composting. Once they had confirmed that sufficient opportunities existed to reduce solid waste through a composting program, the airport initiated a small pilot program with three restaurants. The process started with a walk-through of the establishment to identify opportunities for collection of compostable organics such as food waste, coffee grounds, paper, napkins, and others generated in the back of house. The walk-through was performed by airport staff with a key coordinator, who was designated the responsibility by the food services establishment, and members of the custodial staff, who were responsible for waste collection at the airport.

Providing the Tools

To facilitate implementation, airport staff provided compostable bags, which they were able to purchase at a reduced rate with a state contract, training aids, and marketing materials to each concession. Regular meetings were held with the key contacts and custodial staff to assess performance. The custodial staff were trained and empowered to provide feedback on the effectiveness of the organics collection to the restaurants, thus providing near-time opportunities for corrective action. The trained custodial staff's involvement was important given the turnover of personnel in many of the food establishments.

Airport staff found that the amount of compostable material generated varied among food concession operations. Those operations that bring in food prepared elsewhere generated less compostable material than did those who performed preparation on site. Acting on this knowledge, airport staff developed targeted tools for different types of restaurants, including fast food and restaurant style.

From Pilot to Full Scale

Based on the success of the pilot, airport staff decided to roll out the composting program at all of its food concessions. Rather than rolling it out everywhere at once, MSP replicated the pilot process, moving through the terminal by area to be able to provide the same level of support to each concessionaire without overburdening resources. Currently, there are 28 restaurants at Terminal 1-Lindbergh participating in the program, and in the near future, all restaurants at the airport are expected to be participating in the program (Figure 21).

Closed Loop System

The airport organics composting system is closed loop. After the organic waste is picked up from the concessionaire, it is compacted at the airport and sent off site to a commercial composting facility. The airport uses finished compost for landscaping.

Keys to Success

To start, the MSP took advantage of its sustainability-centered community culture. Airport staff found that food vendor employees who had worked at outside restaurants were familiar with organics recycling. The use of posters to assist and guide employees in identifying compostable materials was a highly effective training tool.

Providing persistent training was another important component in the program. The high turnover of staff is a fact of life in these types of establishments. Understanding this situation, airport staff averted a

FIGURE 21 Map of composting locations.

potential deterioration of the compliance with the program over time by empowering the custodial staff to provide critical near-time feedback to the concessions.

Further Composting Opportunities

With a large number of food vendor contracts up for renewal in 2015, the airport has the opportunity to incorporate provisions in the request for proposal that would allow greater composting, including front-of-house composting. Airport staff are considering requiring the use of biodegradable utensils and serving ware. If the airport expands the program to the front of house for the public, a new training program tailored for the public will be needed.

Notable Achievements

In 2012, the airport was able to divert and compost 161 tons of food waste, keeping it out of the local waste stream. Recovery rates for compostable organics are between 25 and 30 tons a month. The airport is able to divert approximately two-thirds of its waste stream to recycling and organics composting, each comprising approximately one-third of the waste stream.

For more information on MSP's sustainability practices, see http://www.mspairport.com/about-msp/sustainability.aspx.

40

GREEN CONSTRUCTION—USING LIFE-CYCLE AND LIFE-CYCLE COST ANALYSIS TOOLS TO SUPPORT SUSTAINABLE PRACTICES: PHOENIX SKY HARBOR AIRPORT

Drivers	Outcomes	Lessons Learned
• City policy requiring use of LEED • Need for a comparable standard for horizontal projects • Unique physical environment	For taxiway construction: • 16% savings in water usage • 39% reduction in particulate emissions • 26% reduction in energy used for material production • $1.5 million reduction in costs	• Green construction practices can result in reduced cost over the life of the asset • Guidance on green construction must be continually updated, and training must be continually provided • Airport management must be informed on the benefits.

The Context

As a city-owned airport, Phoenix Sky Harbor Airport (PHX) follows city policy and uses the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) for new and major renovation building construction. Nonetheless, a significant number of the primary construction projects are "nonbuilding" horizontal projects, such as airfield pavement and lighting, baggage conveyor systems, parking lots, and other heavy civil work projects to which LEED does not speak directly. This issue came into focus in the construction of the Taxiway C project. An opportunity to review a previously developed pavement design for the project allowed the use of the Transportation Research Board's PaLATE Pavement Life-Cycle Assessment Tool (TRB Model) for Environmental and Economic Effects, which resulted in a more sustainable, less costly modified design. Other initiatives, including requiring cleaner emissions construction equipment for the project, reduced the environmental impacts of the project during construction (Figure 22).

Finding Unique Solutions for Unique Challenges

As a result of these challenges, PHX developed its own Design and Construction Services Division (DCS) Green Guide to foster the development of sustainable projects and reduce resource use and operating costs. The Guide consists of two parts: one for project designers and one for contractors. The Guide is structured in a manner similar to that of LEED, with guidance checklists and scoring, so project professionals and contractors familiar with LEED can readily apply the Guide for PHX projects. The Guide requires design reviews of new technologies and methods, life-cycle

FIGURE 22 Taxiway C.

> **Life-Cycle Assessment** is a technique used to assess environmental impacts associated with all the stages of an asset's life, from raw material extraction through materials processing, manufacture or construction, distribution, use, repair and maintenance, and disposal or recycling. LCA can assist in selecting between options by allowing comparison of the full environmental impacts associated with the potential choices.
>
> **Life-Cycle Cost Assessment** is an economic technique to help answer investment questions about the best value over the life of an asset. It considers not just cost to construct, but also costs to operate, repair, and maintain the asset over its life.

assessments (LCA), and life-cycle cost analysis (LCCA) screening for projects. It also requires plans and methods to reduce construction impacts.

The requirements for LCA and LCCA are important components in ultimately bringing more sustainable projects to the airport. An LCA can clearly demonstrate the reduction in environmental impacts associated with more sustainable options. LCCA can frequently demonstrate that these options are less costly than traditional options over the life of the project. Reduction in raw material use, use of recycled material, installation of water conservation, and energy efficient technologies may initially cost more but are all examples of sustainable practices that can reduce a project's environmental impacts and its true lifetime cost, eliminating the false choice of cost or sustainability. The PHX experience demonstrates that project designers and project managers can use LCCA early in the design process to evaluate new construction alternatives and rehabilitation strategies for existing assets.

LCCA Steps

The process starts with the project team identifying reasonable design project alternatives. For each alternative, the team identifies the initial construction or rehabilitation costs and the necessary ongoing maintenance activities with the timing of those activities and energy costs.

Once the initial and ongoing operations and maintenance expenditure streams are determined for each alternative, the total life-cycle costs for each are calculated. With the information derived from this step, a schedule of activities is constructed for each project alternative.

The next step involves selecting which payback method will be used for the project. The two most common methods used to determine costs are simple payback models and discounting. PHX confers with the city project manager to determine which methodology to use.

The last step is to revisit the design or preservation strategy behind the project using the results of the analysis. This information is then used to determine which project alternative is implemented.

> **Discounting** accounts for the time value of an investment and is used to convert anticipated future costs to present dollar values so lifetime cost of different alternatives can be compared directly.
>
> **Simple payback** derives the amount of time required for a project investment to be repaid by dividing total project cost by amount of estimated savings.

Toolkit Focuses on Four Project Categories

To assist with this process, PHX has developed an LCCA toolkit for four project categories: lighting, motors, mechanical systems, and pavement. To develop the toolkit, PHX researched LCCA methodologies and tools to project impacts and outcomes when applying performance standards of the DCS Green Guide. The tools are all publicly available applications.

> **PHX LCCA TOOLKIT**
>
> **Lighting:** EPAct/Energy Estimator is a simple life-cycle cost calculator for lighting alternatives.
>
> **Motors:** MotorMaster+ includes life-cycle costing, energy accounting, and evaluation of commercially available motors.
>
> **Mechanical Systems:** eQuest is used for analyzing mechanical systems in enclosed, conditioned spaces such as airport terminals and heated hangars.
>
> **Pavement:**
>
> AirCost—An LCCA tool for evaluating pavement options with differing life-spans.
>
> PaLATE Pavement Life-Cycle Assessment Tool (TRB model) for Environmental and Economic Effects combines LCA and LCCA analysis in one tool.

Lessons Learned

PHX identified a number of lessons learned from developing the Green Guide and LCCA Toolkit. PHX emphasized the need for constant training and the need to keep current the Green Guide.

Another lesson was that project managers need to clearly explain the benefits to airport managers such that they can implement the most sustainable projects. Management must support using these tools as part of the project's goals to ensure their use.

Notable Achievements

PHX used initiatives later included into the DCS Green Guide and the PaLATE Pavement Life-Cycle Assessment Tool for the design of Taxiway C. Ultimately, the chosen alternative, which involved reusing the existing paving as subbase and cement slurry for conditioning unsuitable soils rather than transporting in engineered fill, was constructed using green practices. The chosen alternative

- Saved 16% in water used,
- Reduced particulate emissions by 39% during construction,
- Reduced material production energy by 26%, and
- Saved $1.5 million in project costs—mostly from extensive pavement recycling and subbase soil supplementation.

GREEN PERFORMANCE REPORTING—USING THE GLOBAL REPORTING INITIATIVE FRAMEWORK: HARTSFIELD–JACKSON ATLANTA INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• Desire for a mechanism to communicate the sustainability achievements of Hartsfield–Jackson Atlanta International Airport (ATL) • A need for metrics to assess practices and drive the implementation of ATL's sustainability management plan • A commitment to the use of best practices	• B+ rating from GRI for its baseline report • ATL's sustainability achievements are now available for the world to review	• Metrics and performance data may not be available to fully report on performance • Additional studies or data may be needed to fully report on environmental impact use, build on what others have done, and share what you have done.

The Context

When ATL staff decided to measure and track the airport's sustainability initiatives, existing best practices were considered. ATL staff were looking not only for a reporting scheme to communicate the airport's sustainability achievements, but also were seeking a broader perspective of best practices for tracking and verifying sustainability. Airport staff considered:

- GRI Sustainability Reporting Guidelines Airport Operators Sector Supplement;
- SAGA Resource Guide; and
- ICLEI STAR Community Index, Module 1: Sustainability Assessment and Climate Protection.

Industry Best Practices

ATL staff selected GRI because it provided a comprehensive sustainability reporting framework to measure and report economic, environmental, social, and governance performance. It provided the added benefit of incorporating the principles of SAGA (which are airport-specific) and ICLEI (which is used by the city of Atlanta).

ATL staff decided not only to use the GRI framework to track its performance but also opted to submit the airport's sustainability report to GRI. The airport reported under the G3 framework, which includes supplemental sector reporting for airport operations. (At the time of publishing, a new G4 framework has been released, and the approach to sector supplements is being revised.)

> **The Global Reporting Initiative (GRI)** is an international nonprofit organization providing a comprehensive sustainability reporting framework that enables all types of organizations to measure and report their economic, environmental, social, and governance performance. Guidelines can be found at https://www.globalreporting.org/resourcelibrary/G3-Guidelines-Incl-Technical-Protocol.pdf and https://www.globalreporting.org/reporting/g4/Pages/default.aspx.
>
> The **Sustainable Aviation Guidance Alliance (SAGA)** is a volunteer coalition of aviation interests formed to assist airport operators of all sizes in planning, implementing, and maintaining a sustainability program. SAGA consolidates existing guidelines and practices into a comprehensive, searchable resource that can be tailored to the unique requirements of individual airports of all sizes and in different climates/regions in the United States. See http://www.airportsustainability.org/.
>
> The **International Council for Local Environmental Initiatives (ICLEI)** is a membership association of local governments committed to advancing climate protection and sustainable development. ICLEI's **STAR Community Index (STAR)** is a strategic planning and performance management system that offers local governments a road map addressing the three intertwined facets of sustainability: economy, environment, and society. STAR provides a standard framework of sustainability goals and validation measures. See http://www.icleiusa.org/library/documents/STAR_Sustainability_Goals.pdf.

Reporting on Achievements

Within the baseline GRI report, ATL staff reported on an extensive set of sustainability practices that were in place for 2011. These include:

- LEED gold certification for the new international terminal;
- Green construction practices. including use of recycled content material for construction and the diversion of demolition and construction waste from landfills;
- Water reclamation for cooling tower and chiller use;

- Rainwater harvesting for irrigation; and
- Accomplishments in carbon footprint reduction and energy and water conservation.

Commitment to Process

The ATL staff's commitment to implementing best practices included a commitment to process and governance, as well as the specific practices that promote sustainability. ATL's sustainability management plan provides a road map for its sustainability efforts with procedures and review processes with ranking systems for proposed projects to allow prioritization and selection based on environmental, social, and economic concerns. The GRI reporting supports the plan by providing measures of actual performance that can be used to assess the effectiveness of the planning effort as well as the success of the practices.

Verification

ATL staff had their report verified to the limited assurance level, which means the process to develop it was verified. Airport staff understand that planning requires metrics to verify and track results, something that they see as an opportunity for improvement for the whole industry.

Taking an Industrywide Perspective

ATL staff see the airport as one that works on developing its own best practices and sharing with others. The staff work from the perspective that airports are a community of sustainability practitioners who gain from sharing. The GRI reporting supports this perspective. In furtherance of this perspective, ATL staff hosted the 2012 International Airports Seminar with Paris to exchange ideas and best practices that will reach airports all over the world.

Notable Achievements

The airport's sustainability staff submitted baseline information to the GRI and received a rating of B+ in November 2012, becoming the second airport in the country to receive such a high rating. The airport credits much of its success in sustainability to the leadership of the current mayor of Atlanta.

Reference

For further information on the 2011 GRI sustainability report, see http://www.atlanta-airport.com/docs/Airport/Sustainability/2011AnnualSustainabilityReport2011-15-12.pdf. For more information on the 2011 sustainable management plan, see http://www.atlanta-airport.com/docs/Airport/Sustainability/SustainableManagementPlan.pdf.

GREEN BUILDINGS AND CONSTRUCTION—DEVELOPMENT OF A GREEN DESIGN AND CONSTRUCTION MANUAL LEADS TO AN INTEGRATED APPROACH TO SUSTAINABILITY: CHICAGO O'HARE INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• The airport modernization effort presented a unique opportunity to introduce green practices • Existing construction rating systems were not relevant in the airport context	• The Sustainable Airport Manual (SAM) has been used to incorporate sustainability in more than 100 projects • SAM is recognized as best management practice in the industry	• Positive recognition can influence the adoption of sustainability by airport stakeholders • Maintenance and oversight of the rating system is key.

The Context

In 2003, O'Hare International Airport (ORD) was undertaking a substantial modernization effort, the O'Hare modernization program (OMP), and the Chicago Department of Aviation wanted to ensure that sustainability was integrated into all aspects of the program. Recognizing that no clear guidance for green airport construction existed at the time, the airport developed the Sustainable Design Manual (SDM), which provides guidance, case examples, and a "green airplane" rating system to encourage sustainable airport design and construction. The SDM later became the Sustainable Airport Manual (SAM), which was expanded to incorporate guidance for airport administration, planning, operations and maintenance, and concessions and tenants. SAM and the green airplane rating system are frequently cited as a best practice across the industry.

> **Sustainable Airport Manual: Purpose**
>
> "The purpose is to integrate sustainability practices early in the design process, through planning, construction, operations, maintenance and all airport functions with minimal impact to schedule or budget."—SAM

Guidance, Ratings, and Recognition

ORD staff developed an approach to sustainable airport development that relies on:

- Providing guidance for integrating and fostering green practices for design and construction; planning; operations and maintenance for the airport; and for concessions and tenants
- A checklist and green airplane rating system for scoring the integration of green practices
- An award program that recognizes the use of green practices
- Recognition of designers and contractors for accomplishments in sustainability.

Building on LEED to Develop Airport-Specific Construction Practices

For the development of their green building practices, ORD staff based their effort on LEED. Over the years airport staff have updated and revised their efforts, considering and incorporating changes in LEED, changes in regulations, and the airport's own experience with green design and construction. In 2011, an update to SAM added a chapter for design and construction projects of concessions and tenants, as well as daily operations. The most current update of SAM (Version 3.0) occurred in 2012.

> The LEED certification program provides independent, third-party verification that a building has been designed, constructed, operated, and maintained using strategies aimed at achieving high performance in the areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

Green Airplane Rating Process

A critical component of SAM is the green airplane rating system, which is used to evaluate a project's sustainability. Every project at ORD goes through the green airplane rating process.

Specific categories of sustainable practices are assigned a range of possible points depending on whether the project meets or exceeds requirements, standard practices, recommended practices, or best practices (Table 3). Projects must document meeting the criteria outlined in each practice to attain points. This may include providing procedures, studies, calculations, and data. Total points achieved for the project are compared with total possible points for the project, and green airplanes are awarded.

TABLE 3
GREEN AIRPLANE SCORING

All applicable prerequisites +6 points	1 airplane
20% of total applicable points	2 airplanes
30% of total applicable points	3 airplanes
50% of total applicable points	4 airplanes
80% of total applicable points	5 airplanes

Source: First Environment, Inc.

46

The total number of green airplanes the project must achieve is not mandated, but the rating system has been influencing and encouraging projects to be more sustainable. All concessionaires must meet the middle tier of sustainability starting in 2014.

Implementation and Review Process

The Sustainable Review Panel, consisting of management, design, and construction representatives; project management staff; master civil engineers; and airport staff actively involved in the projects, administers SAM's green airplane rating process. They review all submittals and checklists with respect to sustainability, provide technical support to each project, and award "green airplane certification" ratings to projects.

Public Recognition of Achievements

ORD provides public recognition and holds award ceremonies for highly rated projects. Airport staff maintain a "green wall" that showcases different projects. It has become a way of sharing new ideas and has encouraged all parts of the airport to integrate green initiatives into projects. Some tenants and concessionaires have embraced this process, and their achievements have become part of their branding efforts (Figure 23).

FIGURE 23 ORD green wall.

Notable Achievements

The SAM now integrates sustainability into all aspects of airport construction, operations, and maintenance. It is reviewed annually by the ORD Sustainable Review Panel and is updated, as needed, with newer more comprehensive versions. Over the years, more than 100 projects have been rated using this process, with an increase from 32 projects being SAM rated in 2010 to 82 projects in 2012. For one project, incorporating sustainability eliminated 700,000 construction vehicle trips from nearby neighborhoods; it also helped during the airport's writing of its environmental impact statement to proactively address issues.

For more information on SAM, see http://www.flychicago.com/OHare/EN/AboutUs/Sustainability/Sustainable-Airport-Manual.aspx.

LAND USE—APPLYING TRIPLE-BOTTOM-LINE THINKING TO REGIONAL DEVELOPMENT: TORONTO PEARSON INTERNATIONAL AIRPORT

Drivers	Outcomes	Lessons Learned
• Rethinking the role of the airport in supporting the region • Ensuring the long-term future of the airport and the region	• Partners in Project Green received ACI award for Innovative/Special Projects • More than 2,500 companies in the Toronto Pearson Eco-Business Zone implemented energy reduction programs that saved a combined 5.4 megawatts of electricity and more than 3.6 million cubic meters of natural gas	• Have ambitious aspirations • Take advantage of regional and public private partnerships • Look for opportunities beyond the airport fence line.

The Context

Since 1996, environmental stewardship has been one of the cornerstones of the mission of Toronto Pearson International Airport's (YYZ). The airport has as an aspirational goal to be a world leader in airport sustainability. Building on the airport's mature sustainability practices and EMS, YYZ is now bringing a regional perspective to its sustainability practices.

Triple-Bottom-Line Thinking Results in a Regional Approach

Employing triple-bottom-line thinking as an underlying structure for its sustainability practices, the airport's approach to sustainability focuses on the integration of profit, planet, and people. The airport has been broadening its role in achieving sustainability beyond the immediate environment and the physical confines of the airport, defining successful practices as those that support the airport's role within the larger society.

Toronto Pearson International Airport Rules for Effective Sustainability Practices:

• Use benchmarking to attain best practices
• Activate employee engagement and measurable results with management systems and communications
• Find linkages within the triple bottom line
• Focus resources on the objectives
• Use standards, such as LEED, as an education tool

In servicing 36 million passengers last year and with projections that those numbers will grow to upward of 60 million in the next 20 years, the airport is one of the drivers of the regional economy, as a direct and indirect supplier of employment; the indirect employment includes jobs related to providing air transport services to businesses, organizations, and households in the greater Toronto area. In considering how the airport will survive and prosper in the future, airport staff understand

that YYZ is integrally tied to the survival and prosperity of the community and region as a whole. One area the airport has leveraged in supporting the community is the expertise in addressing energy efficiency, air emissions, GHG emissions, and stormwater protection it has developed through its green practices. In addition, airport staff have realized that environmental investments often could be lost if those upstream and downstream of the airport do not make similar improvements.

Regional Approach

Acting on this expanded understanding of sustainability, YYZ staff in 2008 launched Partners in Project Green, a public-private partnership led by the airport and regional and local planning authorities. Working with the private sector, the group created the Toronto Pearson Eco-Business Zone, which encompasses almost 30,000 acres around the airport and crosses four municipalities. The Partners in Project Green provides businesses within Eco-Business Zone the opportunities for networking and collaboration that help them reduce energy and resource costs, identify new business opportunities, and address everyday operational challenges using cost-effective and environmentally sound solutions. In addition, the group coordinates the development of green infrastructure within the Eco-Business Zone.

As a specific example of how the airport's interests and the interests of the surrounding community interact in Partners in Project Green, two of its members, one of which was a roofing company, worked together to develop a "cool roof program." As part of the initiative, local disadvantaged youth have been hired as apprentices and integrated into the roofing industry. Recognizing the synergies, the airport has invested, as has the larger community through the Partners in Project Green, to ensure that skilled and knowledgeable workers are developed. Many of the buildings in the Eco-Business Zone date to the 1980s and need new, more energy-efficient roofs. Partners in Project Green implemented a training program in which disadvantaged youth are trained to be roofers who can properly install new energy-efficient, white roof membrane technologies.

Notable Achievements

In its first year, more than 2,500 companies in the Toronto Pearson Eco-Business Zone reported implementing energy reduction programs that saved a combined 5.4 megawatts of electricity and more than 3.6 million cubic meters of natural gas. The works of Partners in Project Green have also resulted in the growth and financial success of companies that provide green technology. This initiative is becoming a model of regional green economic development and in 2009 received the ACI award for Innovative/Special Projects.

For more information on YYZ environmental initiatives, see http://www.torontopearson.com/en/aboutpearson/environment/initiatives/#. The Partners in Green Projects website is at http://www.partnersinprojectgreen.com.

CONCLUSIONS

LITERATURE REVIEW

The literature review established that sustainability practices are firmly established in the airport industry. It also demonstrated sustainability practices are being integrated into airport planning processes and that this effort is being supported by the FAA, ACRP, and other critical stakeholders. With regard to the reporting of performance, guidelines and standard reporting criteria are available to the industry, but consensus on standardization is less established.

SURVEY

The survey results, although primarily for large hub airports, established that about one-third of the airports had fully developed sustainability programs. The top five drivers for programs were compliance concerns; desire for improved sustainability performance; cost reductions; neighbors and community; and demonstration of leadership in the community. The outcomes showed a moderate correlation to the drivers, with the top three positive outcomes being improved sustainability performance; recognition of leadership in the industry; and greater management confidence. Risk reduction, protection of environmentally sensitive receptors, improved compliance and regulator relationships, and improved tenant and customer relationships were all tied for fourth place.

Organizationally, all the airports surveyed have a sustainability policy in which their sustainability initiatives are founded and about one-third manage their green initiatives through an environmental management system (EMS), four of which are certified to ISO 14001. Overall, the environmental staff was most relied upon for green practices. Operations and maintenance staffs also have a significant presence. However, in general the airport environmental staff and airport management provided the leadership roles. The airports assess the performance of their sustainability practices, and most include cost savings. However, the airports are collecting monitoring and measuring data that are applicable to each individual airport; it is unclear if the measures are consistent or if they are considered best practices.

Most of the airports report on their sustainability practices, and of those that report, most report to the public as well as internally. The most frequently used tools for communicating were a sustainability report and a website.

Airports have overcome barriers to implementing practices through creative approaches. For example, in overcoming limited funding, airport staffs have turned to grants and other alternative financing mechanisms, such as energy service companies (ESCOs). Use of public-private partnerships was also cited as an effective way to overcome barriers.

The survey respondents expressed that their greatest successes were implementation of particular practices in areas where they can improve their focus on governance and process. Finally, their plans for the future have a major governance focus, indicating that the development of green practices starts with a focus on the practices themselves. In addition, establishing the structure and process for incorporating green initiatives into airport operations is recognized as an important component of successful implementation.

CASE EXAMPLES

The case examples illuminated a range of practices and illustrated how each airport incorporated its own individual situation into its practices, leveraging its opportunities and strengths.

COMMON THEMES

The combination of surveys and case examples has provided the opportunity to explore common themes in the implementation of green practices, both from a process perspective and the content of the practices themselves. When examined through the lens of the case examples, drivers for sustainability appeared to reflect a common approach; however, the results of the interviews indicated that the drivers are more nuanced, often reflecting characteristics that are unique to the airport or the community in which the airport exists. For example, the survey identified compliance as the most important driver of sustainable initiatives, and the California Integrated Waste Management Act of 1989 and San Francisco's Zero Waste Goal, which requires San Francisco to achieve zero waste by 2020, has resulted in San Francisco International Airport (SFO) developing one of the largest recycling and composting programs in San Mateo County. In addition, the San Diego green transportation case example was certainly compliance related; however, on closer examination, it was tied integrally to the airport's new master plan that was critical to a much-needed expansion of the airport. In another example, Phoenix took the city's green building requirements and developed a version that was tailored specifically to airport projects.

The green initiatives are often not stand alone; they are components of the airports' mission and overall strategies used to meet that mission. On further examination, it is also clear that airport staffs are recognizing airports' larger role within society and that the development of their practices is informed by that understanding. This theme was repeated in many of the case examples. For example, at Toronto Airport, this understanding has led to an integration of triple-bottom-line thinking (people, planet, profit) into the facility's wider initiatives in and with the communities served. With their public-private partnership, Partners in Project Green and Toronto Pearson Eco-Business Zone demonstrate the understanding that green initiatives within the larger community are key to the future prosperity of the airport and its surrounding community.

It is also clear that the airport staffs are willing to reach out to their colleagues and borrow good ideas. For example, several survey respondents referenced the Chicago Sustainable Airport Manuel (SAM) as the inspiration for their own green building and construction process. However, the programs they implement reflect their knowledge of their airport's capabilities and what makes the most sense. The Minnesota composting program is a back-of-the-house effort that builds on the experience in recycling in the restaurant sector, whereas the San Francisco effort includes passengers and builds on their successful recycling program in the public areas of the terminals.

Another theme that was supported by survey results and the case examples is that cost savings can make an initiative an easy sell. Staff at Newark Liberty International Airport (EWR) developed a program to identify and implement energy efficiencies that will pay for themselves. Staff at Montréal–Pierre Elliot Trudeau International Airport, while seeking a less expensive way to heat the facility's terminal expansion, discovered that the airport could benefit from selling carbon credits.

Airport staffs are also recognizing the importance of governance and process to support their green initiatives. Within the case examples, several airport staffs particularly recognized the role of and credited their EMS in driving their initiatives. This theme was reinforced by the survey results in which the respondents, when asked about their airport's future plans, replied they would improve the underlying structure and processes that support green initiatives. Some mentioned developing an EMS or hiring specific program resources; others mentioned reaching out and including stakeholders and staff more effectively.

Consensus was also seen in the areas of assessing performance and reporting on performance. Most airports track performance through metrics and assess the data for trends. However, the type of performance data collected depended on the practice. Third-party verification of reporting is also not a common practice at this time.

Finally, all respondents recognized that their green initiatives had brought substantial benefit to the airport from the standpoint of improving the airport's sustainability performance, recognition, and improved stakeholder relationships.

FUTURE RESEARCH

Opportunities for future research related to this synthesis include:

1. Case examples for smaller airports—A gap in the study was that only medium and large hub airports participated in the study. It would be very useful to provide case examples on small airports to provide data for peer airports that face similar financial and organizational constraints that medium and large airports may not. The case examples would provide examples for other airport staffs to learn from and implement sustainability initiatives at their own airports.
2. Comprehensive finance and costs study—This would provide guidance to airport staffs considering implementing sustainability initiatives and managing them. Concepts covered could include but are not limited to:
   – Cost tracking;
   – Financing options for practices;
   – Collection of information on financial benefits for sustainability initiatives;
   – Quantification of financial benefits and monetization of nonfinancial societal and Environmental benefits;
   – Life-cycle cost analysis;
   – ROI; and
   – Tools for tracking costs.
3. A study of organizational barriers to implementing and tracking sustainability initiatives. The survey touched on barriers and how they were overcome. However, future research would provide insight into why this is occurring and provide solutions.
4. Research and guidance on how to structure and implement sustainability. The survey generally expressed a need to share sustainability responsibilities across the organization. A study of airports that has been successful at this would be beneficial to other airports. This research would also develop guidance for incorporating sustainability into airport development plans and airport master plan programs.
5. Development of airport management system guidance. Airport staffs identified the need for management systems that incorporate sustainability. The guidance could include an integrated approach to asset, enterprise risk, health and safety, environmental, information, maintenance, and sustainability initiatives management.
6. Study of performance monitoring and reporting systems. Multiple systems were identified for performance monitoring and reporting in the survey. A study of these would provide comparisons for airports considering adopting them. This could result in the identification of quantitative standards and methods to monitor and measure green initiatives to allow benchmarking across airports.

52

REFERENCES

Berry, F., S. Gillhespy, and J. Rogers, *ACRP Synthesis 10: Airport Sustainability Practices*, Transportation Research Board of the National Academies, Washington, D.C., 2008, 120 pp.

Denver International Airport [Online]. Available: http://business.flydenver.com/community/masterplan/faqs.asp. 2013.

Elkington, J., *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*, Capstone Publishing, Oxford, 1997.

Federal Aviation Administration (FAA), *Report on the Sustainable Master Plan Pilot Program and Lessons Learned*, FAA, Office of Airport Planning and Programming, Washington, D.C., Dec. 17, 2012.

Freestone, R. and D. Baker, "Spatial Planning Models of Airport-Driven Urban Development," *Journal of Planning Literature*, Vol. 26, No. 3, 2011, pp. 264–279.

Global Reporting Initiative (GRI), *Sustainability Reporting Guidelines & Airport Operators Sector Supplement*, GRI, Amsterdam, the Netherlands, 2011.

Hartsfield–Jackson Atlanta International Airport, Sustainable Management Plan, 2011 [Online]. Available: http://www.atlanta-airport.com/docs/Airport/Sustainability/SustainableManagementPlan.pdf.

Institute for Sustainable Infrastructure (ISI), "Envision" [Online]. Available: http://www.sustainableinfrastructure.org/rating/index.cfm.

International Council for Local Environmental Initiatives (ICLEI), 2013.

Magnotta, P. *FAA's Sustainable Master Plan Pilot Program,* Office of Airport Planning and Programming, FAA, Washington, D.C., Nov. 15, 2010.

Minneapolis–St. Paul International Airport [Online]. Available: http://www.mspairport.com/about-msp/sustainability.aspx.

Montréal–Pierre Elliot Trudeau International Airport [Online]. Available: http://admtl.com/AboutUs/Environment/AeroEco.aspx.

Montréal–Pierre Elliot Trudeau International Airport [Online]. Available: http://www.csaregistries.ca/cleanProjects/masterprojectdetails.e.cfm?pid=217.

O'Hare International Airport [Online]. Available: http://www.flychicago.com/OHare/EN/AboutUs/Sustainability/Sustainable-Airport-Manual.aspx.

Port of New York and New Jersey [Online]. Available: http://www.panynj.gov/about/pdf/newark-liberty-sustainable-management-plan.pdf.

Port of Portland [Online]. Available: http://www.portofportland.com/prj_POP_HQP2_Home.aspx.

Port of Portland [Online]. Available: http://www.pdxairportfutures.com/Documents/PDX_AF_Sust_rpt.pdf.

Ritter, M., G. Bertelsen, and Z. Haseman, *ACRP Report 57: The Carbon Market: A Primer for Airports*, Transportation Research Board of the National Academies, Washington, D.C., 2011, 80 pp.

San Diego International Airport, 1995 [Online]. Available: http://energycenter.org/programs/san-diego-airport-clean-vehicle.

San Diego International Airport [Online]. Available: http://sustain.san.org.

San Francisco International Airport [Online]. Available: www.flysfo.com/sustainability.

Sustainable Aviation Guidance Alliance (SAGA), 2013.

Toronto Pearson International Airport [Online]. Available: http://www.torontopearson.com/en/aboutpearson/environment/initiatives/#.

Toronto Pearson International Airport, Partners in Green Projects [Online]. Available: http://www.partnersinprojectgreen.com.

U.S. Green Building Council (USGBC), Leadership in Energy and Environmental Design (LEED), 2000.

Wyman, O., *Guide to Airport Performance Measures,* Airports Council International (ACI), Montreal, Quebec, Canada, 2012.

ANNOTATED BIBLIOGRAPHY

Aeroports de Paris, *2011 Corporate Social Responsibility Report*, Paris, France.
Keywords: Paris, sustainability report, corporate social responsibility, Global Reporting Initiative

Airports Council International (ACI), *World Report 2012*, Washington, D.C., Apr. 2012.
Keywords: sustainability, emissions, environmental issues, economic and social impacts

Barrilleaux, J., "Sustainable Planning Makes $$ and Sense," Presented at ANM Conference, Apr. 17, 2012.
Keywords: Federal Aviation Administration, sustainability, economic viability, operational efficiency, natural resource conservation, social responsibility

Brown, J., "Indian Airport Goes Green," *Civil Engineering News*, Dec. 2007.
Keywords: India, Airports Authority of India, airport expansion, sustainability, terminals

CDM, *Enhancing the Airport-Industry SAGA Website*, *ACRP Project 02-30*, Transportation Research Board of the National Academies, Washington, D.C., 2014.
Keywords: ACRP, SAGA website, sustainable practices, guidelines

Chartered Institute of Logistics and Transports, *British Aviation's 'Green' Initiative*, *CILTWorld*, Issue 12, p. 23.
Keywords: Britain, green initiative, carbon dioxide emissions, sustainable aviation

Farley, D., "The Not So Green Skies," *Scientific American*, Vol. 301, No. 3, Sep. 2009, pp. 21–22.
Keywords: airline industry, airports, recyclables, cost control, environmental aspects

Federal Aviation Administration (FAA), *Report on the Sustainable Master Plan Pilot Program and Lessons Learned*, FAA, Office of Airport Planning and Programming, Washington, D.C., Dec. 17, 2012.
Keywords: Federal Aviation Administration, Sustainable Master Plan Pilot Program, environmental impacts, stakeholders

Fortmeyer, R., "LEED, Green Initiatives Find Widespread Favor in Energy-Intensive Airport Terminals," *Architectural Record*, Vol. 194, No. 10, Oct. 2006, p. 47.
Keywords: LEED, Logan International Airport, energy-efficient, green initiatives

Francis, G., I. Humphreys, and J. Fry, "The Benchmarking of Airport Performance," *Journal of Airport Transport Management*, Vol. 8, No. 4, 2002, pp. 239–247.
Keywords: airports, benchmarks, best practice benchmarking

Freestone, R. and D. Baker, "Spatial Planning Models of Airport-Driven Urban Development," *Journal of Planning Literature*, Vol. 26, No. 3, June 2011, pp. 264–279.
Keywords: airport planning and development, airport city, aerotropolis, urban models, sustainability

Global Reporting Initiative (GRI), *Sustainability Reporting Guidelines & Airport Operators Sector Supplement*, GRI, Amsterdam, the Netherlands, 2011.
Keywords: Global Reporting Initiative, sustainable development, data gathering, airports

Hewitt, W., "The Only Way to Fly," American Planning Association, Nov. 2007, pp. 22–25.
Keywords: green initiatives, sustainability, Chicago, San Francisco, Portland, JFK

International Civil Aviation Organization (ICAO), *Global Aviation and Our Sustainable Future: Briefing for RIO +20*, ICAO, Montreal, Quebec, Canada, 2012.
Keywords: aviation, green economy, sustainable development, alternative fuels

Kasarda, J., *The Rise of Aerotropolis*, The Next American City Inc., Dec. 12, 2007, pp. 1–3.
Keywords: aerotropolis, infrastructure, sustainability

L2I Financial Solutions, *Aeroports de Montreal's Energy Efficiency Measures for GHG Emissions Reductions Project: Greenhouse Gas Emissions Reductions Report*, Montreal, Quebec, Canada, Apr. 2010.
Keywords: Montreal Airport, greenhouse gas reduction, energy efficiency, technology

Luther, L., *CRS Report for Congress: Environmental Impacts of Airport Operations, Maintenance, and Expansion*, prepared for Members and Committees of Congress, Apr. 5, 2007.
Keywords: Federal Aviation Administration, Century of Aviation Reauthorization Act, environmental impacts, airport operations, stakeholders

Magnotta, P., *FAA's Sustainable Master Plan Pilot Program*, Office of Airport Planning and Programming, FAA, Washington, D.C., Nov. 15, 2010.

54

Keywords: Federal Aviation Administration, Sustainable Master Plan Pilot Program, sustainability initiatives, triple bottom line

Ritter, M., G. Bertelsen, and Z. Haseman, *ACRP Report 57: The Carbon Market: A Primer for Airports*, Transportation Research Board of the National Academies, Washington, D.C., 2011.

Keywords: greenhouse gas emissions, carbon markets, carbon credits, carbon offset

Ruble, V., *Status Report on Sustainable Airports in the United States: Case Study of Chicago O'Hare International Airport*, Research Papers, Paper 105, 2011.

Keywords: Chicago O'Hare, sustainable policies, environment, sustainable airport planning, triple bottom line

Tegtmeier, L., "Sustainable Savings," *Aviation Week and Space Technology*, Vol. 172, No. 35, Sep. 20, 2010, p. 65.

Keywords: sustainable buildings, airports, green maintenance, greenhouses gases, cost control

Upham, P., "A Comparison of Sustainability Theory with UK and European Airports Policy and Practice," *Journal of Environmental Management*, Vol. 63, 2001, pp. 237–248.

Keywords: aviation, sustainability assessment, European Union, United Kingdom, environmental management

U.S. General Accounting Office, *Aviation and the Environment: Airport Operations and Future Growth Present Environmental Challenges*, Report to the Ranking Democratic Member, Committee on Transportation and Infrastructure, House of Representatives, GAO/RCED-00-153, Washington, D.C., Aug. 2000.

Keywords: airports, federal laws, environmental challenges, Clean Air Act, operations and growth

Vanasse Hangen Brustlin, Inc., *Airport Sustainability Practices: Tools for Evaluating, Measuring and Implementing*, ACRP Project 02-28, Transportation Research Board of the National Academies, Washington, D.C., 2013.

Keywords: ACRP, sustainability, airports, SAGA, stakeholder feedback, best practices

Wyman, O., *Guide to Airport Performance Measures*, Airports Council International, Montreal, Quebec, Canada 2012.

Keywords: airport performance indicators, benchmarking, key performance areas, environmental

APPENDIX A

SUMMARY OF GREEN PRACTICES AT AIRPORTS

A summary of all the green practices for all the airports is provided here. The table demonstrates that every Global Reporting Initiative (GRI) category was represented. The number of categories for each airport ranged from 1 to 9. Some airports had more than one practice for each category. The most predominant category was waste and recycling (13 airports). The least represented category was climate change and adaptation, for which a practice is being developed at BOS.

The following is a complete list of all the practices grouped by category. The practices for which the airports reported are summarized by category. Some of the practices were unique, and some were found at a number of airports.

Water Resources

- Water conservation and stormwater management program;
- Rental car turnaround facility water conservation measures;
- Aircraft deicing fluid collection;
- Surface water monitoring; and
- Fuel and other hazardous materials spill reduction.

Land Use

- Wetland mitigation; and
- Adoption and implementation of tree policy and green projects in surrounding communities.

Air Quality and Greenhouse Gas (GHG) Emissions

- GHG inventory, criteria air pollutant annual inventories;
- GHG reductions;
- Sustainable guidelines for operation and maintenance;
- Ground transportation alternative fuel vehicles;
- Aircraft fuel hydrant system;
- Provision of 400-Hz and preconditioned air at gates;
- Energy efficiency, electrification of GSE;
- Air quality management program; and
- Clean cabs, alternative fuel shuttle buses, and financial incentives for alternative fuel vehicles.

Waste and Recycling

- Waste recycling;
- Waste recovery programs;
- Food donations;
- Landfill diversions;
- Composting;
- Recycling improvements;
- Collection of organics;
- Waste contractor agreements; and
- Program in sustainability master plan funded by FAA.

56

Noise

- Noise abatement programs; and
- Residential and school sound insulation programs.

Adaptation to Climate Change

- Infrastructure vulnerability assessment that focuses on climate change.

Life-Cycle Assessment

- Airports identified using LCCA tools as way to identify total cost of ownership of projects and used for decision making at design phase.

Material Purchasing and Use

- Tracking as an objective and target in ISO 14001 EMS;
- Carpet replacement policy—reuse and recycle where feasible; and
- Environmentally preferable purchasing policy.

Green Buildings

- LEED for new and renovated terminals, office buildings, rental car facilities; energy retrofit program.

Green Construction

- LEED guidelines, developed sustainable design guidelines and sustainable infrastructure guidelines.

Green Transportation

- CNG shuttle fleets;
- Direct light rail (MAX) connection to airport;
- Bicycle/multiuse path, assembly station/bike racks;
- EV charging stations;
- Conversion of ground support equipment to alternative fuels; and
- Trip reduction program.

Energy

- Carbon footprint reduction and energy management strategy;
- Parking guidance system;
- Goals to reduce energy and water use per passenger in 2008 by 20% in 2020;
- Goal for development of energy efficiency and alternative energy to meet 15% percent of total energy use by the airport;
- Energy conservation, energy efficiency retrofits;
- Photovoltaic solar panel installation;
- Use of LED lamps on both airside and groundside;
- Power generation using natural gas; and
- Energy efficiency initiative evaluating projects.

SUMMARY OF GREEN PRACTICES BY CATEGORY

Airport	Category Number	Category Name	Green Initiatives	Age (y)	Goal Set	Monitored/Measured
Boston	4.17	Adaptation to climate change	Beginning infrastructure vulnerability assessment that will focus on climate change	0	No	No
Boston	4.12	Air quality and greenhouse gas emissions	Clean cabs, alternative fuel shuttle buses, financial incentives for alternative fuel cabs	6	No	Yes
John Wayne	4.12	Air quality and greenhouse gas emissions	Electrification of GSE	10	Yes	Yes
Minneapolis	4.12	Air quality and greenhouse gas emissions	GHG inventory/reporting	10	Yes	Yes
Montreal	4.12	Air quality and greenhouse gas emissions	Energy efficiency and GHG emissions reduction of the terminal building through an improved HVAC	10	Yes	Yes
Oakland	4.12	Air quality and greenhouse gas emissions	Ground transportation alternative fuel ordinance	12	Yes	Yes
Oakland	4.12	Air quality and greenhouse gas emissions	Provision of 400-Hz and preconditioned air at gates	6	Yes	Yes
Oakland	4.12	Air quality and greenhouse gas emissions	Aircraft fuel hydrant system	30	No	Yes
Phoenix	4.12	Air quality and greenhouse gas emissions	GHG inventory and criteria air pollutant annual inventory	20	Yes	Yes
San Diego	4.12	Air quality and greenhouse gas emissions	Air quality management program	5	Yes	Yes
San Francisco	4.12	Air quality and greenhouse gas emissions	Sustainable guidelines for operation and maintenance	0	Yes	Yes
Atlanta	4.9	Energy	Reduction by 20% of 2008 energy and water use levels per passenger by 2020	2	Yes	Yes
Atlanta	4.9	Energy	Development of energy efficiency and alternative energy to meet 15% of the total energy use by the airport	2	Yes	Yes
Boston	4.9	Energy	Energy efficiency initiative evaluating projects	3	Yes	Yes
Chicago	4.9	Energy	Energy efficiency retrofits for Chicago Department of Aviation facilities	5	Yes	Yes
John Wayne	4.9	Energy	Power generation using natural gas	2	Yes	Yes
Minneapolis	4.9	Energy	Alternative energy	10	Yes	Yes
Montreal	4.9	Energy	Use of LED lamps both on airside and groundside	5	No	Yes
Oakland	4.9	Energy	Photovoltaic solar panel installation	6	No	No
Phoenix	4.9	Energy	Energy conservation	5	Yes	Yes
Portland	4.9	Energy	Carbon footprint reduction and energy management strategy	1	Yes	Yes
Portland	4.9	Energy	Parking guidance system	1	Yes	No
San Diego	4.9	Energy	Energy conservation program	5	Yes	Yes
Boston	4.6	Green buildings	LEED-like sustainability guide design	4	Yes	Yes
Boston	4.6	Green buildings	Consolidated rental car facility, LEED silver	0	Yes	Yes
Minneapolis	4.6	Green buildings	Remodeling project	5	Yes	Yes

(continued on next page)

58

SUMMARY OF GREEN PRACTICES BY CATEGORY
(*continued*)

Airport	Category Number	Category Name	Green Initiatives	Age (y)	Goal Set	Monitored/Measured
Newark	4.6	Green buildings	Energy efficient retrofit program	3	Yes	Yes
Oakland	4.6	Green buildings	LEED	6	No	Yes
Portland	4.6	Green buildings	LEED platinum Port headquarters	3	Yes	Yes
San Diego	4.6	Green buildings	LEED renovation project	5	Yes	Yes
San Francisco	4.6	Green buildings	Guidelines for planning, design, and construction	1	Yes	Yes
Atlanta	4.7	Green construction	Development of green construction and green procurement manuals	2	Yes	Yes
Chicago	4.7	Green construction	Require adherence to the sustainable airport manual green rating system for airport design, construction, and operations	10	Yes	Yes
Newark	4.7	Green construction	Sustainable design guidelines and sustainable infrastructure guidelines	6	Yes	Yes
Phoenix	4.7	Green construction	LEED and PHX design and construction green guide	7	Yes	Yes
Boston	4.8	Green transportation	26 EV charging stations	2.5	No	Yes
Boston	4.8	Green transportation	Alternative fuel shuttle bus system	20	Yes	Yes
Charlotte	4.8	Green transportation	Expansion of EV charging stations	1	Yes	Yes
Montreal	4.8	Green transportation	Alternative transportation program	4	No	Yes
Newark	4.8	Green transportation	Use 20% biodiesel on all diesel-powered equipment; 100% of light duty vehicles purchased are alternative fuel	10	Yes	Yes
Oakland	4.8	Green transportation	EV charging stations	14	No	Yes
Oakland	4.8	Green transportation	Conversion of ground support equipment to alternative fuels	6	Yes	Yes
Oakland	4.8	Green transportation	Trip reduction program	8	Yes	Yes
Phoenix	4.8	Green transportation	CNG buses since 1994; clean fuels requirement via contract with taxis, van service for 15 years	19	Yes	Yes
Portland	4.8	Green transportation	CNG shuttle buses	12	Yes	Yes
Portland	4.8	Green transportation	Direct light rail (MAX) connection to airport	11	Yes	No
Portland	4.8	Green transportation	Bicycle/multiuse path/assembly station/racks	10	Yes	No
San Diego	4.8	Green transportation	Clean air vehicle conversion program	5	Yes	Yes
Minneapolis	4.11	Land use, biodiversity, wildlife management, and restoration	Wetland mitigation	10	Yes	No
Montreal	4.11	Land use, biodiversity, wildlife management, and restoration	Adoption and implementation of a tree policy and green projections in surrounding communities	4	No	Yes
Phoenix	4.16	Life-cycle assessment	LCCA/LCA	2	No	Yes
San Diego	4.16	Life-cycle assessment	LCCA/total cost ownership program	2	Yes	No

SUMMARY OF GREEN PRACTICES BY CATEGORY
(*continued*)

Airport	Category Number	Category Name	Green Initiatives	Age (y)	Goal Set	Monitored/Measured
Boston	4.5	Material purchasing and use	Through ISO 14001 system	9	Yes	Yes
Phoenix	4.5	Material purchasing and use	Environmentally preferable purchasing policy	6	No	No
Portland	4.5	Material purchasing and use	Reducing hazardous materials in maintenance operations	10	Yes	Yes
Portland	4.5	Material purchasing and use	Carpet replacement project (~12 acres)	0	Yes	Yes
Chicago	4.14	Noise	Residential and school sound insulation programs	30	Yes	Yes
John Wayne	4.14	Noise	Noise abatement program	20	Yes	Yes
Minneapolis	4.14	Noise	Noise abatement program	20	Yes	Yes
Oakland	4.14	Noise	Noise management program	37	Yes	Yes
Phoenix	4.14	Noise	Noise	22	Yes	Yes
San Francisco	4.14	Noise	Noise abatement program	20	Yes	Yes
Toronto	4.14	Noise	Noise abatement program	40	Yes	Yes
Boston	4.13	Waste and recycling	Waste contractor agreement	0	No	No
Boston	4.13	Waste and recycling	Beginning to develop SMP funded by FAA	0	Yes	Yes
Chicago	4.13	Waste and recycling	Waste recovery program	3	Yes	Yes
Denver	4.13	Waste and recycling	Landfill diversion	8	Yes	Yes
John Wayne	4.13	Waste and recycling	Recycling of wastes	4	Yes	Yes
Minneapolis	4.13	Waste and recycling	Reducing and recycling wastes	10	Yes	Yes
Montreal	4.13	Waste and recycling	Domestic waste recycling program in the terminal building, including the collection of organics	10	Yes	Yes
Montreal	4.13	Waste and recycling	Recycling and demolition of waste	5	No	Yes
Newark	4.13	Waste and recycling	Waste reduction and recycling improvement program	1	Yes	Yes
Oakland	4.13	Waste and recycling	Waste reduction and recycling	10	No	Yes
Phoenix	4.13	Waste and recycling	Waste recycling	23	Yes	Yes
Portland	4.13	Waste and recycling	Food donation	0.75	Yes	Yes
San Diego	4.13	Waste and recycling	Waste reduction program	10	No	Yes
San Francisco	4.13	Waste and recycling	Achieve a solid waste recycling goal of 80% by 2015	20	Yes	Yes
Toronto	4.13	Waste and recycling	Recycling	20	Yes	Yes
Chicago	4.10	Water resources, wastewater, stormwater	Install green roofs on all new airport facilities	10	Yes	Yes
Denver	4.10	Water resources, wastewater, stormwater	Aircraft deicing fluid collection	8	Yes	Yes
John Wayne	4.10	Water resources, wastewater, stormwater	Surface water monitoring	20	Yes	Yes
John Wayne	4.10	Water resources, wastewater, stormwater	Fuel and other hazardous materials spill reduction	20	Yes	Yes

60

SUMMARY OF GREEN PRACTICES BY CATEGORY
(*continued*)

Airport	Category Number	Category Name	Green Initiatives	Age (y)	Goal Set	Monitored/Measured
Minneapolis	4.10	Water resources, wastewater, stormwater	Water quality programs	10	Yes	Yes
Montreal	4.10	Water resources, wastewater, stormwater	Centralized aircraft deicing facility and recycling of fluid	16	No	Yes
Phoenix	4.10	Water resources, wastewater, stormwater	Water conservation program, stormwater program	15	Yes	Yes
Portland	4.10	Water resources, wastewater, stormwater	Rental car quick-turnaround facility water conservation measures	1	Yes	Yes
San Diego	4.10	Water resources, wastewater, stormwater	Stormwater management program	10	Yes	Yes
San Francisco	4.10	Water resources, wastewater, stormwater	EMS for all compliance activities	0	Yes	Yes

APPENDIX B

OPEN-ENDED QUESTIONS

ACRP SYNTHESIS S13-02-10: OUTCOMES OF GREEN INITIATIVES AT AIRPORTS

The 15 airports indicated in the survey that they have:

- Improvements,
- Successes, and
- Future plans.

The airports were asked open-ended questions about these areas, and the responses are shown here.

IMPROVEMENTS

The 15 airports were asked the open-ended question, "What would you do differently in terms of your sustainability practices?" The airports had various responses that focused on policy, goals, planning, organizational structure, budgeting, monitoring and measurement, tenants and stakeholders, as well as climate change mitigation and adaptation. The airports' responses are:

- Establish the sustainability policy earlier.
- Establish an airport EcoDistrict.
- Enhance work with the tenants and airlines to create an airportwide sustainability management plan.
- Establish a sustainability budget to fund certain projects.
- Move sustainability position to a higher reporting in management.
- Engage more heavily in climate change mitigation and adaptation dialogue with constituents.
- Incorporate a more formal planning and collaboration process with clear lines of accountability for meeting well-established sustainability goals across the organization.
- Try harder to portray the benefits of sustainability initiatives.
- Build stronger organizational structure around sustainability.
- Engaging with tenants and other stakeholders is a top priority; so far our efforts have been largely internal. Eventually, we would like to move away from a stand-alone initiative and integrate sustainability principles into the short- and long-term strategic and business planning process.
- Continuing to refine goals (including monitoring and measuring associated metrics).
- Seek support from the other stakeholders (and most importantly other departments within the company).
- Have people understand that sustainability is not just environmental issues but part of an airport's strategic long-term planning. How do I put more planes over the community and have them thank me for it?
- Do more checking in and measuring progress more frequently.
- Establish a sustainable management plan immediately after adoption of a sustainability policy.
- I would have every job description include sustainability responsibilities.

SUCCESSES

The airports were asked the open-ended question, "What has been your greatest success?" The responses provided topics and discussion points for the in-depth interviews for the case examples.

Some responses pointed to the successful implementation of a particular practice:

- Creation of the green construction and green procurement manuals.
- Upcoming completion of the implementation of the organics composting program.
- Development of ongoing working groups.

62

- Energy projects are by far the easiest to sell.
- The new thermal plant achieved a 70% energy efficiency improvement. This project resulted in the transaction of carbon credits on the voluntary market.
- Noise and stormwater runoff quality.
- Over 50% conversion of entire airport taxi fleet to meet Low Carbon Fuel Standard within a 9-month period.

Others focused on developing processes that underlie the development of sustainable practices with answers such as:

- Green construction/LEED classes for staff/energy savings from this.
- Fast implementation.
- Sustainability management plan.
- Education of the staff on the importance of sustainability practices and making sustainability a normal part of our daily jobs.
- Airport deicing fluid collection, communication of processes.

Other airports focused on perceptions resulting from the implementation of practices. These responses included:

- Building internal support and showing that the airport can be a leader in sustainability practices (LEED, among first to install EV chargers, lead on energy issues, etc.).
- Ability to maintain leadership position in industry.
- Airport held up to community as model.

FUTURE PLANS

The survey asked, "How do you hope to improve in your sustainability practices over the next 5 years?" All of the airports have significant plans. All the responses focused on the development of processes and structures that will support sustainability practices rather than specific new initiatives. The airports responded:

- Continue to integrate triple-bottom-line sustainability into airportwide operations and culture. Working collaboratively with all of the airport users, tenants, airlines, concession, to create one plan and one implementation strategy to meet the agreed to goals and initiatives.
- Establish 5-year stretch goals and end-of-year objectives.
- Processes that incorporate the tools developed into specs, etc., so that there are "no questions," better communications.
- Pursue GRI.
- Establish reporting dashboard.
- Set aggressive long-term goals.
- Implement our ongoing sustainability initiatives for planning, design and construction; building automation; and environmental management systems.
- Develop initiatives for zero waste generation, further greenhouse gas emission reduction, and climate change adaptation.
- Improve policy development, planning, implementation, and reporting.
- Implement sustainability action plan that requires the participation of external stakeholders (concessionaires, tenants, taxi drivers, etc.).
- Address waste and recycling issues on a broader level and creating a framework for tenant and stakeholder participation.
- Continue to refine goals (including monitoring and measuring associated metrics).
- Integrate 20-year strategic plan into the 5-year plan.
- Get more support from upper management.
- Develop and implement a sustainability master plan.

APPENDIX C

ELECTRONIC SURVEY RESPONDENTS

Name of Airport	Airport Code	Airport Size	Location
Boston Logan International Airport	BOS	L	Massachusetts
Charlotte Douglas International Airport	CLT	L	North Carolina
Chicago O'Hare International Airport	ORD	L	Illinois
Denver International Airport	DEN	L	Colorado
Hartsfield–Jackson Atlanta International Airport	ATL	L	Georgia
John Wayne Airport, Orange County	SNA	M	California
Minneapolis–St. Paul International Airport	MSP	L	Minnesota
Montreal–Pierre Elliot Trudeau International Airport	YUL	L	Montreal, Québec, Canada
Newark Liberty International Airport	EWR	L	New Jersey
Oakland International Airport	OAK	L	California
Phoenix Sky Harbor International	PHX	L	Arizona
Portland International Airport	PDX	M	Oregon
San Diego International Airport	SAN	L	California
San Francisco International Airport	SFO	L	California
Toronto Pearson International Airport	YYZ	L	Mississauga, Ontario, Canada

Abbreviations 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