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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP RESEARCH REPORT 205

Revolving Funds for Sustainability Projects at Airports

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AIRPORT COOPERATIVE RESEARCH PROGRAM

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FOREWORD

By Theresia H. Schatz
Staff Officer
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ACRP Research Report 205 provides guidance for determining if establishing a dedicated revolving fund for sustainability projects is the right funding approach for your airport. The report also provides instructions on how to implement and best utilize this solution. Green revolving funds (GRFs) offer an alternative approach for investing in projects that generate operational savings and will provide a way to advance an airport's sustainability goals.

While there are several potential sources for funding airport sustainability projects [capital budget, utility rebates and subsidies, and competitive grants such as FAA's Voluntary Airport Low Emissions Program (VALE)], these sources each have challenges in terms of use and availability. An innovative approach to address these challenges is to establish and make use of a revolving fund for sustainability projects tailored to airports. By adopting this approach, airports will gain the ability to track savings or revenues from other capital projects and apply those benefits to new sustainability projects. An airport could then leverage those financial benefits into flexible, self-financing opportunities for future sustainability projects.

Research under ACRP Project 02-77 included several nonairport-related case examples that have managed GRFs for over a decade and two airport-related case examples. Potential funding sources and options to establish the initial seed funding for GRFs are also provided. Additional resources consist of process flow diagrams that identify the critical decision-making steps necessary to develop and optimize the GRF; descriptions of effective performance-tracking mechanisms; and educational resources and engagement strategies to achieve consensus among internal and external stakeholders.

The research team was led by staff from Rocky Mountain Institute in association with staff from Cadmus, Sustainable Endowments Institute, and Frasca & Associates, LLC.

CONTENTS

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

SUMMARY

Revolving Funds for Sustainability Projects at Airports

Airports continually balance demands to improve infrastructure with the realities of available budgets. Green revolving funds (GRFs) offer an alternative approach for investing in projects that generate operational savings. The fund works by tracking verified cost reductions from implemented actions, and then transferring those savings to a reserve that provides capital for future qualified projects such as energy system upgrades. These savings become a new resource that can reduce pressure on existing capital and operational budgets. A number of universities have managed GRFs for over a decade. Municipalities are starting to adopt them as well. Airports require a modified GRF approach because of financial structures, Federal Aviation Administration (FAA) regulatory requirements, airline agreements, and the wide range of tenant roles.

This ACRP report provides guidance to determine whether this innovative funding approach is suitable for a particular airport and instructions on how to deploy it. Airports that have the ability and determination to launch a GRF will gain a robust method for advancing their sustainability goals.

Airport Sustainability Funding Dynamic

Many worthwhile airport sustainability actions are often not pursued because of a lack of funding. Airports may have a limited ability to pursue capital projects that are dedicated solely to increasing efficiency. Planning teams prioritize opportunities that support aircraft operations or enhance passenger terminal capacity. Operational budgets have limited potential to support new projects over other existing recurring expenses. A GRF solves these challenges by creating a dedicated funding stream for sustainability projects that does not compete with existing capital and operating budget priorities.

How a GRF Fund Works

A GRF is an internal investment vehicle dedicated to financing energy efficiency, renewable energy, and other sustainability measures that generate cost savings. These savings are tracked and "revolved" back into the GRF, maintaining the funding stream for sustainability projects over time. GRFs are broadly defined by two criteria:

1. The fund must finance measures to reduce resource use (e.g., energy, water, or waste) or to reduce carbon emissions (e.g., by installing renewable energy technology).
2. The fund must revolve. Savings generated from operating cost reductions attributed to funded projects must be used to fully repay the initial loan or investment.

Once funded, a GRF continues in perpetuity and can invest in sustainability projects without impacting airport capital or operational budgets.

Determining If a GRF Is a Good Fit

GRFs are ideal for airports that want to pursue ambitious efficiency goals and are willing to invest in an unconventional approach. If airports have the vision and commitment to start a GRF, they will typically require 6 to 18 months to obtain resources, educate stakeholders, establish accounting and governance procedures, and promote the program. Airports that have greater autonomy under compensatory contract structures with airlines will be able to move more quickly. Residual and hybrid (combining residual and compensatory) contract structures will require additional effort to negotiate shared savings and create the contractual agreements. The larger the airport property and assets, the greater the potential benefit associated with a GRF.

It is possible that smaller airports, with annual utility costs under $200,000, may find that the labor required to invest in and maintain an airport-level GRF does not justify the potential savings; however, alternative approaches for small airports, such as establishing a state-level GRF, are possible.

How to Implement a GRF

This report presents a 10-step process for planning, implementing, and operating an airport GRF, as shown in Figure 1.

Readers will find more detailed implementation guidance and additional background material within the chapters that follow.

The development and deployment of a GRF requires the support of a variety of key stakeholders. For example, the airport's office of planning and environment or another appropriate line of business needs to designate a point person who can serve as the champion to take ownership and maintain momentum. The airport finance departments need to ensure that either the current accounting system is sufficiently robust to support the GRF accounting and financial reporting requirement or agree to modify or change the system as needed. Facility engineering needs to create a list of potential projects. Operational groups must agree to roles regarding project prioritization and tracking savings. For airports that have a third party manage their utility payments, a new system to monitor bills and payment must be established. Coordination with key tenants is essential. For airlines, this may require new agreements or modified contracts to change the way operational savings are split between parties. Airports may need to start the process for establishing a GRF by incorporating it within airport planning documents for future consideration.

Who Are the Airport GRF Key Parties?

The following airport stakeholders should be part of the GRF process:

- Airport Finance
- Airport Operations and Maintenance
- Airport Environmental Affairs and/or Sustainability
- Airport Planning and Development
- Engineering
- Airlines
- Other Major Tenants

Once there is an agreed process for managing savings, an airport GRF committee can either designate seed money to start the fund (endowment model) or capitalize the GRF through savings from existing projects (savings reclamation model). There are a wide range of funding sources to capitalize the fund, and airports should review the Frequently Asked Questions (FAQs) provided in Appendix A to understand the requirements including those regarding FAA grant funding.

Finally, airports must establish a governance process that is acceptable to all key parties. Then, when funds are available to invest, an airport can install new equipment or other resource efficiency measures from a prioritized project list. Projects with a quick payback are especially attractive for GRFs, because they return money to the

Figure 1. GRF implementation steps.

fund quickly, but a GRF can invest in projects with long and short payback periods. Based on a baseline measurement or actual metered data, the post-project savings can be tracked. Savings from the utility bills are then directed back to the GRF. New investments can be made from the fund, once it holds sufficient resources. Airports can also contribute additional funding to make the GRF grow faster. Once the fund is operational, airport GRF committees should review performance periodically to optimize it.

This report groups the 10 steps into three phases:

Phase 1: Planning—Initiating an Airport GRF

- Step 1: Perform Research—Understand Your Airport
- Step 2: Select a GRF Model
- Step 3: Assess Investment Potential
- Step 4: Engage Stakeholders and Build Buy-In

Phase 2: Implementation—GRF Activation Steps

- Step 5: Secure Seed Capital
- Step 6: Establish Fund Governance and Procedures
- Step 7: Launch the Fund

Phase 3: Operations—GRF Project Implementation and Ongoing Management

- Step 8: Implement Projects
- Step 9: Track, Analyze, and Assess Performance
- Step 10: Optimize and Improve

CHAPTER 1

GRF 101—High-Level Overview

1.1 What Is a GRF?

A GRF is an internal investment vehicle dedicated to financing energy efficiency, renewable energy, and other sustainability projects that generate cost savings. These savings are tracked and "revolved" back into the GRF, maintaining the funding stream for sustainability projects over time. GRFs are broadly defined by two criteria:

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An individual or a committee (existing or newly established) is typically assigned to manage the responsibilities of operating a GRF, which include project identification and selection, implementation, performance tracking, and overseeing financial transfers.

1.2 Benefits of Utilizing a GRF

There are many benefits to utilizing a GRF including the following:

- **Hedging against rising energy prices**—GRFs are an effective strategy for hedging against rising energy prices without the downside of traditional energy price hedges, which incur losses if energy prices stay flat or decline.
- **Institutionalizing a mechanism for funding efficiency**—GRFs provide a perpetual funding source, even if budgets tighten and funding becomes scarcer in the future. A dedicated fund, rather than a series of one-off investments, provides a formal and more secure commitment that ensures cost-saving efficiency projects will be funded.
- **Implementing performance tracking**—A GRF includes measures to monitor cost savings and energy consumption. The collected data can then be used to benchmark against the performance of peer institutions (Sustainable Endowments Institute 2017).
- **Establishing an independent and flexible funding source**—Higher education institutions with operating GRFs have found they have greater latitude to pursue actions with a return on investment (ROI) or payback period that might have been delayed under existing formal processes (Sustainable Endowments Institute 2017).

For airports, there may be additional benefits including the following:

- **Catalyzing sustainability impacts across stakeholders**—A GRF offers an opportunity to recruit airlines and other tenants in a systematic and structured process to save resources. Improved tracking may provide data for future incentives and shared savings.

- **Gaining a streamlined sustainability funding source**—With airline acceptance, an airport could implement the GRF as an independent method to pursue efficiency projects. A new GRF can reduce demands on capital and operating budgets.

1.3 Advantages of a GRF in an Airport Context

The following are several key advantages that GRFs have over traditional non-revolving expenditures (Sustainable Endowments Institute n.d.-a):

Demonstrate the Business Case for Sustainability

Despite the significant operational savings potential of energy efficiency and sustainability investments, airport staff may not fully pursue cost-effective measures. Rather than simply allowing the savings from these projects to be absorbed into the operating budget, a GRF tracks the savings distinctly and directs them into future projects, thus creating a measurable ROI.

Engage and Educate the Passengers and the Public

Traditional capital improvement investments are typically managed by a small team of airport staff. Adopting a GRF can help elevate the profile of these projects by tracking and sharing the enterprise-level benefits achieved through the fund's cumulative impact.

Convey Reputational Benefits

Having a GRF can signal an airport's commitment to sustainability and operational efficiency in a way that one-time investments cannot. It is a unified, purposeful investment vehicle that generates a more compelling organizational story than conventional investments.

Catalyze a Culture Shift

A GRF also represents a commitment to larger airport strategic goals, such as greenhouse gas (GHG) reductions, and provides a tangible vehicle for achieving them. A GRF provides constant focus on the concept of continuous improvement until a carbon footprint of zero is reached. That is unlikely to happen with conventional debt financing or some other kind of capital financing.

Create a Programmatic Approach

A GRF creates a formalized program of sustainability investments rather than a series of one-off projects. GRFs typically include specific requirements to ensure fiscal discipline, environmental responsibility, and a clear financing process that funnels savings from past projects into current airport spending plans. In some cases, this source of funding enables projects to be implemented that may otherwise fail to demonstrate a strong case to pursue.

1.4 Leveraging Savings into Opportunity

A GRF is an effective way for organizations to capitalize on the savings from energy efficiency projects to promote sustainability (Indvik et al. 2013).

By adopting a GRF, airports gain the ability to track savings or revenues from capital projects and apply those benefits to new sustainability projects. The airport can leverage those financial benefits into flexible, self-financing opportunities for future sustainability projects. Figure 2 provides an illustration of the basics of a GRF.

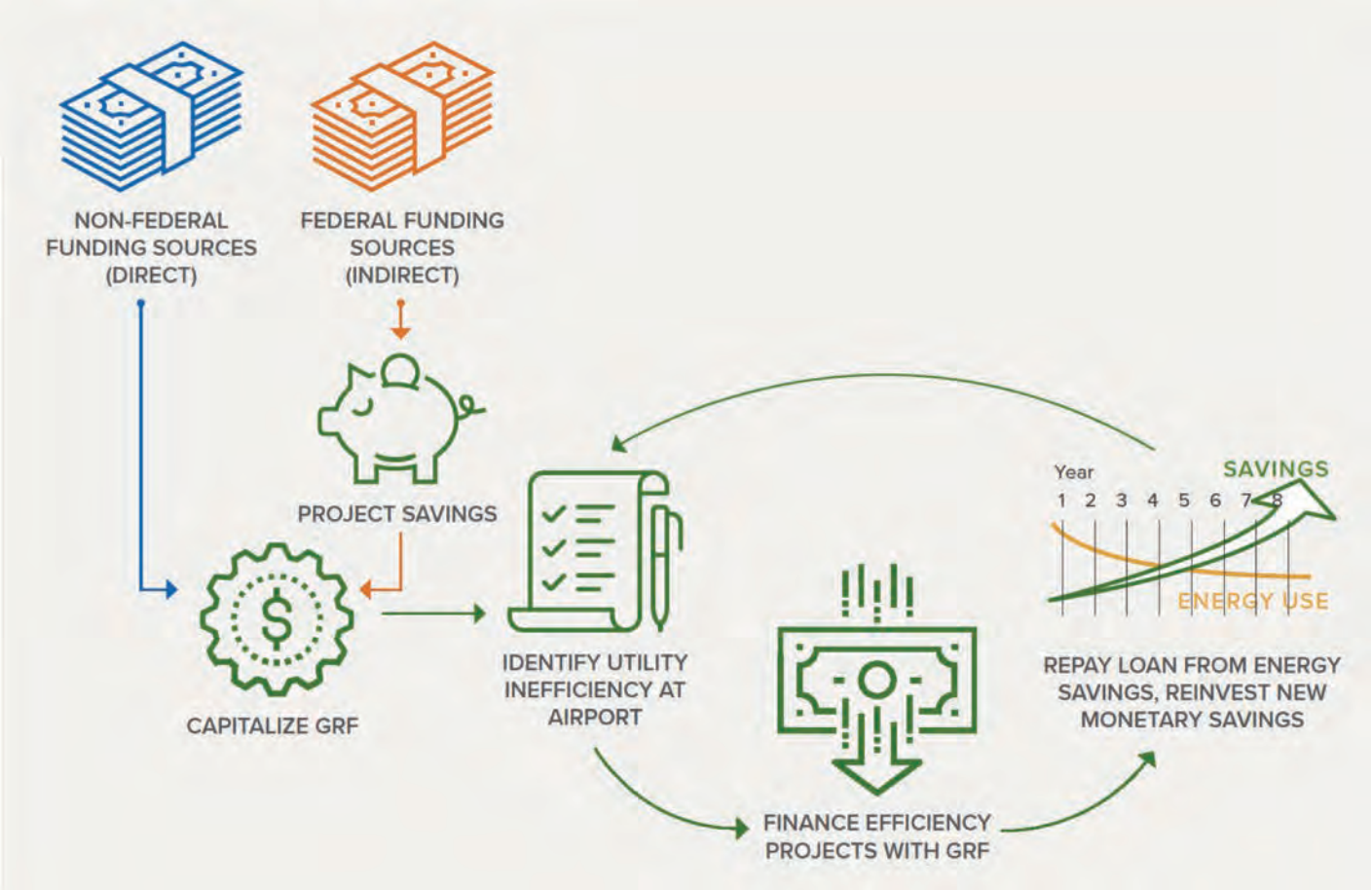

Figure 2. Airport GRF 101.

1.5 Working with Airlines

GRFs are a cost-effective tool for airports and airlines to accelerate resource savings and secure a range of sustainability benefits. This report provides suggestions on how to present the value of GRF to all airport stakeholders including airlines. Airlines may have limited familiarity with the GRF concept. Airports can educate their airline partners and reach agreement on how operational savings can be managed. Section 3.4.2 provides detailed guidance on how to advance GRFs with airlines.

CHAPTER 2

Where Are GRFs Already Working?

2.1 GRF Case Example Summary

The impact of GRFs in catalyzing investment into energy and resource efficiency projects is most robustly represented within higher education, where the financing model has been implemented most frequently. Three of the four GRF case examples included in this report come from institutions of higher education: Harvard University, Denison University, and Lane Community College. The final example profiles the city of Santa Barbara, a municipality that has developed a GRF and also manages a local airport. Airport perspectives are profiled for Hartsfield-Jackson Atlanta International Airport (ATL) (the busiest airport in the United States) and for smaller airports within the Virginia Department of Aviation. A summary of lessons learned is provided herein and a more detailed discussion of each case example can be found in Appendix C.

Higher Education and Municipalities

The case examples of established GRFs can offer multiple valuable lessons for airports that are considering the GRF model. For example, Harvard's experience in setting up a GRF shows that starting with a smaller fund and proving its value can provide a low-risk pathway for creating a large fund over time. Denison demonstrates that it is possible to get a successful GRF operating without initially having tracking and measurement systems in place—estimates for these efficiency projects can be relied on to plan repayments in advance of more robust metering systems. Lane teaches institutions the importance of initially setting up clear fund guidelines and separating the GRF account from other budgets to ensure that funds are protected from budgetary pressure over time. Santa Barbara reinforces the fact that a backlog of energy efficiency projects represents a perfect opportunity to establish a GRF, and that even the initial attention to detail required to set up the fund can lead to significant utility savings (as the city found a better rate structure and used the resulting $60,000 in savings to capitalize its GRF).

Airports

Understanding early exploration of the GRF model in airports can also provide useful lessons. At ATL, the challenge in setting up what may be the first airport GRF has been finding enough funding for projects of sufficient size that are worth tracking and revolving savings. Fund champions have pursued unconventional sources of seed capital, identifying several potential sources. These include rebates from the state utility, savings from efficiency projects financed by the city's revolving fund, a voluntary charge for travelers, and even revenue generated by airport land management. With the investment of the modest capital raised to date into a relatively small project, the savings are currently too small to justify tracking them. More funding will be needed to establish the airport's GRF. ATL's experience demonstrates that even with available sustainability staff committed to the GRF concept, creativity and perseverance may be necessary to generate initial funding for the GRF. It also demonstrates that the strategy of starting with a

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smaller GRF to demonstrate the concept must simultaneously ensure that the GRF can finance projects of sufficient scale with savings that merit tracking. If the GRF is too small, it may give the impression that the model doesn't provide sufficient benefit to warrant expansion.

Although it is not a traditional GRF, the Virginia Airports Revolving Fund (VARF) provides useful insight on how a state-level variation on the GRF concept could work for smaller airports. The Virginia Department of Aviation established the VARF, and though it is not dedicated to financing sustainability projects, the fund does provide loans to Virginia airports for various projects. These loans must be repaid. The airports have a level of familiarity with the revolving fund model and its ability to operate over time, as well as a potential source of seed funding for establishing their own airport-managed GRFs. State-level revolving funds exist across the United States, and to the extent that they can be utilized by airports, they can serve both as an educational and an early financing role for airports looking to establish their own GRF. The administrative requirements are more manageable when centralized out of a single office for multiple facilities.

While GRFs are relatively new to airports, they have been deployed at colleges and universities since the early 2000s. Cities have also implemented GRFs. Because each institution has unique characteristics and organizational structures, it is essential to recognize which GRF features to adapt to work for each airport. While higher education has found value in establishing independent GRFs, it may be more efficient for smaller airports to participate in a statewide system that is centrally administered (similar to the one in Virginia). The research team suggests reviewing the detailed case examples provided in Appendix C for additional information.

CHAPTER 3

Phase 1: Planning—Initiating an Airport GRF

GRFs offer significant benefits and can provide a new framework for managing sustainability actions at airports. Using a GRF structure to support sustainability offers an airport a clear process to prioritize and develop projects based on their cost-effectiveness. Airports may also decide to assign value to actions that achieve social and environmental outcomes. Measures that advance all three components of the triple bottom line (people, planet, profits) could be prioritized over those that may yield fewer benefits. Basing decision-making on prudent economics will help convince a wide range of airport stakeholders that a GRF is worthy of consideration. Airports should review the entire 10-step implementation process and gain familiarity with the requirements of each component before deciding to pursue a GRF.

The first four steps for GRF implementation cover the planning phase. They describe the preliminary actions related to selecting the appropriate structure and generating support from stakeholders (see Figure 3).

When contemplating whether a GRF makes sense for an airport, start by gathering information about potential energy- and resource-efficiency projects that could be funded through a GRF. The airport terminal facilities or operations group may already have a running list of previously identified opportunities or can find potential projects using recent energy audit results. If an airport does not have an existing project list, it may make sense to contact the local utility and schedule a no-cost preliminary audit or site walk-through to identify opportunities. FAA funds can be leveraged to pay for independent energy audits. Airports can also consult relevant ACRP literature and the energy conservation measures listed in Appendix B.

From there, review the airport's governance structure and how sources of funding must be managed. Identifying the advantages and limitations associated with various sources of financing, airport ownership, level of service, and any planning, design, or environmental reviews that may pertain to GRF projects will provide significant insight on the barriers that need to be addressed during the GRF assessment.

After the airport decides that a GRF is worth exploring, contact all affected parties to discuss coordination. Reach out to airlines, concessionaires, and any other parties that have operations in spaces subject to the GRF. Airline buy-in may be essential before an airport dedicates resources and makes commitments. See Section 3.4.2 for suggestions on working with airlines. The research team also suggests including FAA Airports District Office planners and engineers in the dialogue and keeping them updated with developments. Involving all relevant stakeholders

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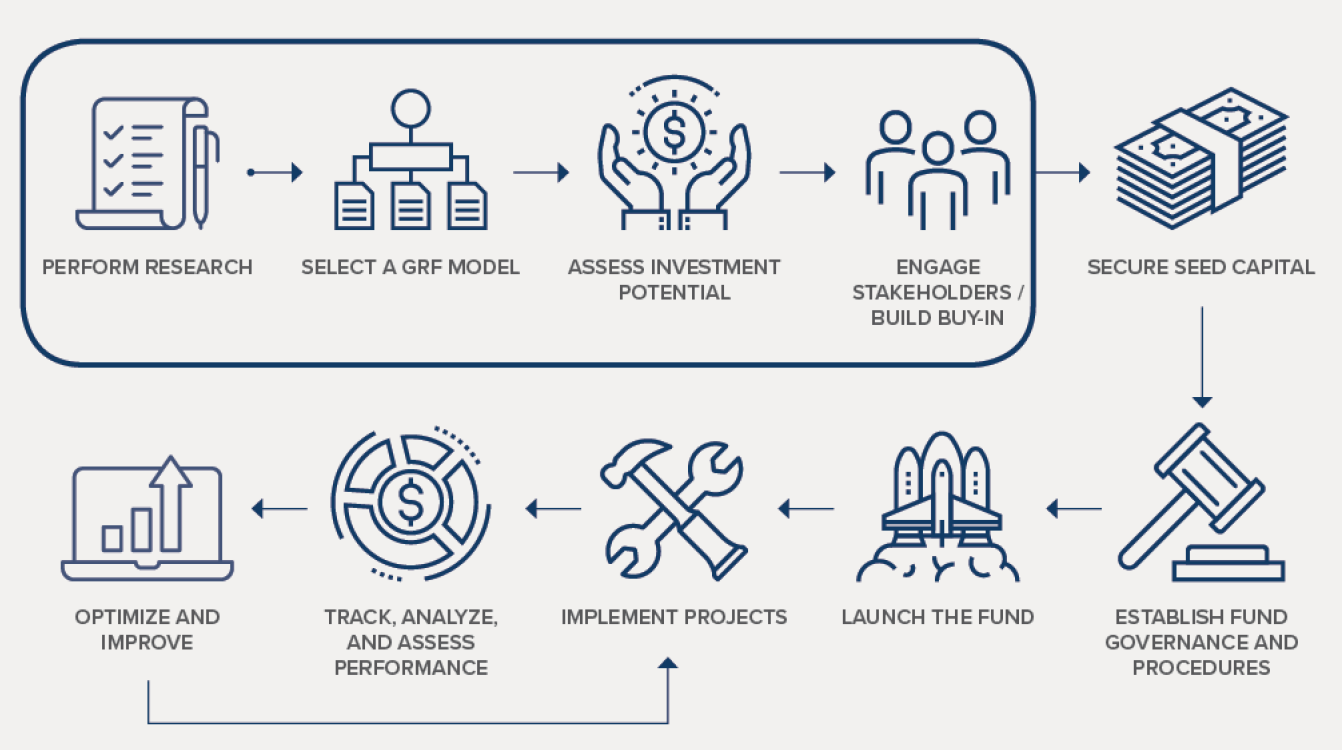

Figure 3. Phase 1: Planning—initiating an airport GRF.

early in the exploration process can increase the likelihood that obstacles will be uncovered, and more support will be provided when the assessment turns into a GRF proposal.

Once stakeholders have been updated, it is important to understand the standard accounting practices used at the airport for resource efficiency projects. Capital will exit the GRF account to pay for the materials and labor associated with a project and potential soft costs that could include contractor designs and environmental review. Future secured project savings must be returned—from the budget in which they accrue—to the GRF account to finance future projects. These transactions must be tracked according to standard airport accounting practices, which will ensure that the circular flow of capital that defines the GRF is maintained. Airports should consider which internal stakeholders would handle the accounting and financial flows for the GRF including tracking the utilities' budget where project savings accrue. If this involves stakeholders in different airport lines of business, do existing channels of communication and collaboration already exist, or must these be developed?

PERFORM RESEARCH

3.1 Step 1: Perform Research—Understand Your Airport

3.1.1 Do the Homework

The first step in developing a successful GRF is to gain an understanding of the range of GRF models and to begin thinking about how the fund can be tailored for an individual airport.

Much work has already been done in this area and using existing materials can cut months from the fund development process. There are two key areas in which research is crucial.

First, learn about existing and relevant GRFs such as those provided in Chapter 2. These could be from other airports, or they could be based at universities and city governments within each airport region. Gain a basic understanding of the structure of these funds, the types of projects they typically finance, and popular variations on the GRF model.

Second, examine the elements of airport operations that are relevant to a GRF. These include the following:

- Long-term planning, environment, and climate goals; related airport plans; regional GHG goals (e.g., climate action plans); and Airport Carbon Accreditation participation.
- How are utility services distributed and paid? Is the entire airport run as one large unit, or is the enterprise split into smaller, autonomous departments or units?
- How is money transferred internally? Airports often have accounts associated with each department and unit, and it may be necessary to secure an account for the GRF.
- Which stakeholders contribute to decisions about facility operations and project finance? Who will need to be consulted to establish buy-in for the fund?
- What is the current state of energy efficiency and auditing at the airport? Have any studies identified potential energy efficiency or sustainability projects?

3.1.2 Airport Budget Structures

The creation and deployment of a GRF has implications for both capital and operating budgets. First, because a GRF revolves over time and reinvests its funding into additional projects, the creation of a GRF can take pressure off future capital budgets by funding projects that would otherwise have been paid from the capital budget. Additionally, the monetary savings associated with commonly funded GRF projects, like energy efficiency and renewable energy (EE/RE), typically accrue to the operating budget. However, GRF investments must be repaid from operational savings for the fund to continue to function. The most common approach with existing GRFs is to use the savings that would have accrued to the operational budget to repay the GRF. This typically requires that a new line item be created for the amount of the GRF repayment, and this needs to be added to the airport's operating budget. Using the operating budget for repayment keeps the benefits (savings) and costs of the project within the same overall budget. Repayments could also be made from capital budgets or from some other separate budget category depending on airport structure and preference.

The airport also needs to be able to access project savings if another cost center, line of business, city department, or other entity has oversight of utility payments. Establish management protocols to obtain utility data and operational savings transfer, if oversight of energy consumption and energy payments are separate for the airport.

3.1.3 Airport Level of Service and Governance Structure

There are over 3,300 existing and proposed airports, identified under the 2019–2023 National Plan of Integrated Airport Systems (NPIAS), contributing essential services to national air transportation (National Plan of Integrated Airport Systems n.d.). Of these airports, more

than 500 are commercial service airports, over 250 are reliever airports, and nearly 2,600 are categorized as general aviation (GA) airports. Regardless of how these airports are identified in the NPIAS, their owner/operator structures, at a high level, can be broken down into either general-purpose governments—municipal, county, or state—or single-purpose entities, such as airport authorities and commissions and private management companies (Reimer and Putnam 2009). The following provides an overview of these airport categories and governance structures, and how they can affect the implementation of a GRF.

Commercial Service Airports—GRF Applicability

Of the more than 500 commercial service airports in the NPIAS—382 primary and 127 non-primary airports—133 account for 96% of all U.S. enplanements (National Plan of Integrated Airport Systems n.d.). Regardless of an airport's level of service, a significant factor to consider when evaluating GRF feasibility at any commercial service airport is the extent to which airport/airline use and lease agreements, as well as other leasehold agreements, will affect the implementation of GRF projects. Airline contracts often include requirements for the airport to share operational cost savings (Vanden Oever et al. 2011). Sharing savings derived from GRF projects may require considerable stakeholder engagement and negotiation. See Airport/Airline Use and Lease Agreements in Section 3.1.5 for additional information. Commercial service airports represent the most complex locations at which GRF may be implemented because of the variety of airport lease agreement structures.

Less Than One Million Annual Passengers

Commercial service airports with less than 1 million annual passenger enplanements generally have limited revenue streams, which may not be available for the capitalization or growth acceleration of a GRF. If annual project savings are equal to or less than the cost of the staff time required to implement and maintain a stand-alone GRF, pursuing a fund does not make sense. GRFs at the state level make more sense for smaller commercial and GA airports as presented in the Virginia Department of Aviation case example in Appendix C.

Greater Than One Million Annual Passengers

Commercial service airports with greater than 1 million annual passenger enplanements typically have a larger diversity of revenue streams that can be allocated to the establishment or acceleration of a GRF. Annual operational savings can also exceed the labor costs associated with developing and implementing a GRF. Some small and most medium and large hub airports will likely have an enhanced ability to generate and retain savings from GRF projects.

Reliever and GA Airports—GRF Applicability

Although a variety of leasehold agreements apply at reliever and GA airports, these airports are not subject to airport/airline use and lease agreements. Airports in these categories may encounter fewer barriers when establishing a GRF; however, given the scale of operations, and the size of the potential utility savings, it is likely more cost-effective for smaller airports to participate in a GRF at the state system level. For information on how the Virginia Department of Aviation set up its revolving fund to support small airports, see the case example in Appendix C.

The lack of revenue sharing agreements at reliever and GA airports may enable GRFs to grow at relatively fast rates compared with GRFs at commercial service airports; however, the scale of operations may limit the size of annual savings at GA airports and thus reduce their revenue benefits. A GRF is not the right solution, if the total dollars saved are lower than the airport cost to establish and maintain a revolving fund. If there is an economic case to proceed, GA airports need to pay attention to tenant contracts.

3.1.4 Airport Owner/Operator Structures

Owner/operator structures can be broken down into either general-purpose governments or single-purpose entities. General-purpose governments may choose to retain direct control over airport decision-making or may retain indirect power through the ability to appoint and remove airport authority commissioners. A noted benefit of general-purpose government's direct control of airport decision-making is the ability of the electorate to vote on the governing body's airport-related decisions (Reimer and Putnam 2009). Conversely, the autonomy of single-purpose entities has also been cited as leading to improved airport performance and efficiency (Reimer and Putnam 2009).

Municipal, County, and State—GRF Applicability

City-owned airports are the most widely adopted ownership model in the United States at 33% of the total. Fifteen percent of airports are operated by counties and 7% are state operated (American Association of Airport Executives 2014). Airports operated completely by either a city or a county will typically fall under the oversight of a division or department of the city or county, and the airport director may report directly to elected officials. According to the American Association of Airport Executives (AAAE) "the advantage of an airport that is municipally owned is that airport administration has access to the resources of the other city or county departments" (American Association of Airport Executives 2014). As described in Section 3.1.3, smaller airports can benefit from a pooled fund at the state level.

Municipalities also have the power to tax and issue bonds on behalf of the operation of the airport. Airports operated by general-purpose local governments, however, can be at a disadvantage given the span of control of elected officials. To ensure that elected officials prioritize airport needs, advisory boards are often created to communicate action recommendations. Advisory boards can also establish airport authorities or commissions (American Association of Airport Executives 2014).

The implementation of a GRF at airports that are directly owned and operated by general-purpose governments has the benefit of access to other department resources. Other departments across the municipality, county, or state may have experience with similar revolving funds and could assist the airport with the implementation and management of a GRF. Additionally, the ability of general-purpose governments to issue bonds on behalf of the airport could provide an additional funding source for GRF projects (see Section 4.1.2 for further GRF funding information). However, in cases where airport decision-making is directly overseen by elected officials, who have numerous priorities, the GRF implementation process may encounter delays. General-purpose governments that establish airport advisory boards to improve the efficiency of airport decision-making may accelerate the adoption and growth of a GRF.

Airport and Port Authority Advisory Boards and Commissions—GRF Applicability

Airport and port authority advisory boards typically consist of representatives with considerable knowledge or expertise relating to the aviation industry. Airport authorities represent 30% of all U.S. airports. The degree of airport authority power is dependent on enabling legislation, which typically includes the power to make daily operational policies and may include the ability to levy taxes as well as use the power of eminent domain. As a more focused entity, airport authorities can allocate resources toward airport-specific business matters rather than general community issues. Airports with greater independence can make more streamlined decisions (American Association of Airport Executives 2014).

Port authorities represent 9% of all airports in the United States. The AAAE defines a port authority as a "legally chartered institution that generally has the same status as a public corporation" (American Association of Airport Executives 2014). In addition to airports, port authorities operate a variety of other public facilities, including harbors, railways, and toll roads. One of the more significant advantages of port authorities is their ability to use revenue from other modes of transportation for airport purposes (American Association of Airport Executives 2014).

Similar to airport authorities, "commissions can have the same responsibilities and stature . . . and are generally established to allow for focused attention and expertise to be applied in operating the airport." Appointed individuals represent the city or county, which can be an asset or drawback because they must be responsive to the political landscape to remain in office (American Association of Airport Executives 2014).

The relative autonomy of airport and port authorities is a significant advantage when considering GRF implementation. The ability of these entities to directly make decisions rather than being required to seek approval from governing bodies will likely help airports under authority control to streamline the GRF adoption. Additionally, although airports must comply with FAA Order 5190.6B (FAA Airport Compliance Manual 2009) and cannot divert airport generated revenue, authorities with operational oversight of multiple airports may be able to use a single GRF across locations as long as each is operated by the same controlling entity. Furthermore, port authorities can share revenue sourced from the various transportation systems under their control with the airport(s) they operate. This could potentially serve as a significant source of funding for GRF projects at airports managed under this structure.

Private Management—GRF Applicability

According to the AAAE, "privatization refers to the shifting of government functions and responsibilities, in whole or in part, to the private sector." Although most commercial and GA airports in the United States are owned/operated by government entities, or by entities enabled or appointed by governments, active private entities play a part in airport operations, development, and management. Approximately 6% of U.S. airports are operated through intercity contracts or by special tax districts (American Association of Airport Executives 2014). Existing research has noted that private participation in airport management is recognized as an opportunity to improve cost certainty and efficiency (Reimer and Putnam 2009). However, privatization of management does not mean that general-purpose governments forfeit all control over the airport.

Detailed agreements, leases, or other contracts determine the extent to which private entities are delegated airport control. Generally, a "private operator's authority over key decisions is often constrained by the long-term lease agreement with the airport owner and the continued application of commitments to the federal government" (Reimer and Putnam 2009). Key barriers that disincentivize airport privatization include the time-consuming transfer process from public to private ownership, restrictive or vague regulatory requirements, and limited access to or use of federal funds (Tang 2017).

Although their autonomy from government control is subject to negotiated lease terms, contracts, and agreements, private management firms operating airports may be able to expedite GRF implementation. As for-profit entities, privatized airport operators may find GRFs attractive with their potential to create an internal funding mechanism that can operate independently from the capital budget process. Private airports may also prefer the simplicity of existing finance options.

3.1.5 Airline and Other Tenant Participation Considerations

Airports derive a significant source of revenue from both airline and nonairline sources, many of which are subject to agreements and leases. Spaces such as airline ticket counters, gates, offices, baggage claim areas, aircraft hangars, and maintenance areas are all examples of airline usage. Nonairline lease spaces can include concessions, vehicle parking areas, advertising spaces, and rental car facilities (American Association of Airport Executives 2014). Airports have a variety of options when it comes to how these leases are structured. The following provides an overview of the primary air carrier (airline) and concessions (nonairline) leasing options available at airports, and how each can affect GRF implementation.

Airport/Airline Use and Lease Agreements

Airport/airline use and lease agreements are legal contracts between the airport operator and the air carriers serving the airport. Use agreements define the rights, privileges, and obligations of airlines and the airport. Use agreements serve multiple purposes (Airports Council International—North America n.d.). First, they establish the business arrangement and rate-setting methodology with the airlines. Second, they identify the areas and facilities (both airfield and terminal) leased by the airlines and the degree of control by the lessee. Third, they define the level of air carrier control over airport expenses. Lastly, they identify general party responsibilities and obligations for indemnification, insurance, environmental issues, and other governmental inclusion (Young and Wells 2004; Faulhaber et al. 2010). Airline cooperation is essential for commercial airports to implement a GRF. See Section 3.4.2 for suggestions on how to generate buy-in and ideas on how sharing the operational savings could work.

Residual Agreements. Residual agreements permit aeronautical users to receive a "cross-credit" of nonaeronautical revenues. Under this structure, the airport applies excess nonaeronautical revenue to airfield-related costs to reduce air carrier fees. In exchange, the air carriers agree to cover any airport budget shortfalls, if nonaeronautical revenue is insufficient to cover airport costs. In a residual agreement, aeronautical users may assume partial or total liability for nonaeronautical costs (FAA Airport Compliance Manual 2009).

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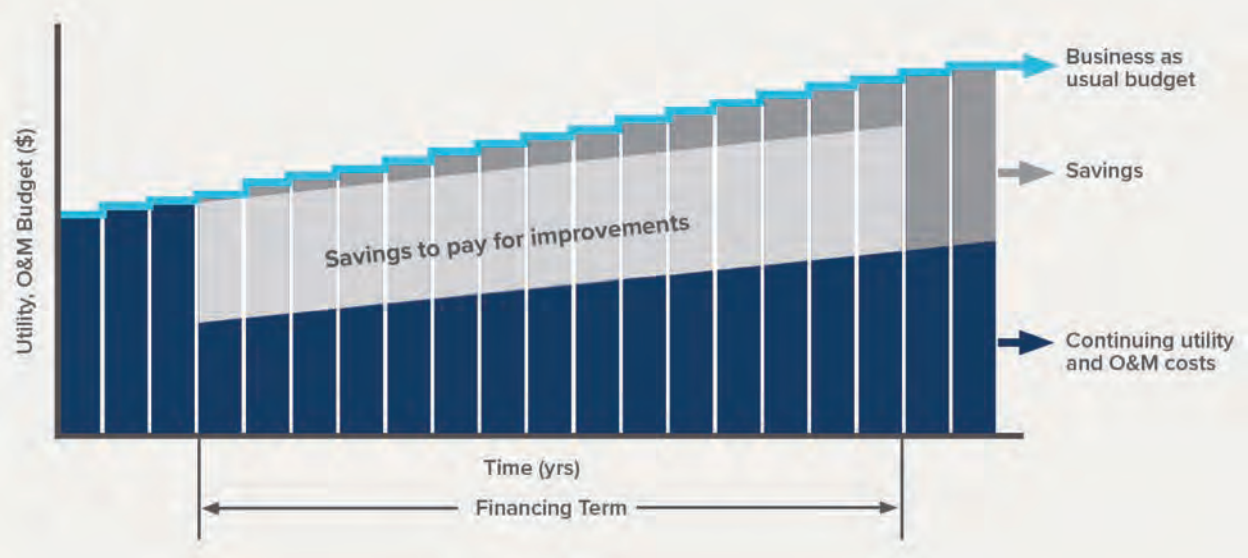

Source: U.S. Department of Energy 2018.

Figure 4. Unlocking operational savings to accelerate resource efficiency.

Stakeholder Impacts. Under a residual agreement, the air carriers that enter into a contract assume significant financial risk by agreeing to keep the airport financially self-sustaining by covering airport losses after factoring in all nonaeronautical revenues (Young and Wells 2004). By assuming such risk, air carriers receive nonaeronautical revenue sharing with the airport to help reduce aeronautical costs (e.g., landing fees, rental rates). Furthermore, Majority-in-Interest (MII) clauses included in residual agreements provide signatory air carriers with greater control over airport capital development because of the risk they assume (Faulhaber et al. 2010).

GRF Applicability. Under a residual agreement structure, air carriers will likely have strong support for a GRF. This is because a decrease in airport operating costs or increase in savings derived from airport implemented efficiency measures would result in a greater chance of the airport recognizing a surplus, which—under a residual agreement—must be shared with the airlines. Therefore, the establishment of a GRF works in favor of both the airport (improved operational efficiency) and the air carriers (increased potential for a rate base reduction). Establishing a GRF under a residual agreement, however, may have a drawback. Air carriers generally have greater influence over capital improvements under residual agreements, which could potentially delay the rate at which GRF projects could otherwise be implemented. Under a business as usual budget, operational costs are higher, and savings are unrealized (see Figure 4).

Airport operators will likely need to engage air carriers to a greater extent under residual use agreements when selecting GRF implementation projects. Effective cooperation between an airport and its airlines is essential to the long-term health of the aviation industry. GRFs offer an opportunity for the parties to align on both sustainability and financial outcomes.

Compensatory Agreements. Compensatory agreements place all liability for airport costs on the airport operator and allow for the retention of all airport generated revenue. Airport

operators may choose to share nonaeronautical revenues, but it is not required. Additionally, air carrier leasehold space charges are set based on the operational cost of the aeronautical facilities used (FAA Airport Compliance Manual 2009). According to *ACRP Report 36: Airport/Airline Agreements—Practices and Characteristics,* "air carrier rates are calculated in the respective rate-making cost center. The total cost requirement of the cost center is divided by the appropriate measure for that cost center (such as total rentable space for the terminal cost center) to arrive at the specific rate" (Faulhaber et al. 2010).

Stakeholder Impacts. Unlike residual agreements where air carriers assume the risk and are responsible for guaranteeing that the airport operator has a balanced budget, compensatory agreements place financial risk on the airport operator. Therefore, airport operators must ensure that nonaeronautical revenues meet the operating needs of the airport. Because air carriers do not take on additional financial risk under this type of lease structure, their control over an airport operator's capital development is limited (Faulhaber et al. 2010).

GRF Applicability. Air carriers may support GRF establishment under a compensatory lease structure. Because the airport operator is solely responsible for its budget, the airport operator will likely be able to implement identified GRF projects with greater independence. This can help grow the fund at a faster rate than could be achieved within a residual contractual framework.

The central premise of a GRF is that operational savings are retained to pay off project "loans." Airlines must agree to forgo reductions in utility, or other potential costs, so that a GRF can be recapitalized. If dedicating 100% of savings is not tenable, a compromise agreement could establish the portion of savings to be shared with airlines. In a split retained/shared savings scenario, the GRF could help reduce air carrier lease rates over time because air carrier rates are set based on the operational costs of space/services used. As efficiency measures capitalized by a GRF are implemented, airline rates may be reduced in proportion to the efficiency improvements made. Although airport operators have considerable control over capital decision-making under compensatory agreements, modification of existing agreements may be necessary to stipulate a new process for reinvesting savings in a GRF. Securing airline buy-in is essential in all cases, and airports can refer to Section 3.4.2 for tips on how to convince carriers that a GRF is a worthwhile joint venture.

Hybrid Agreements. Hybrid agreements can consist of a variety of residual and compensatory rate-setting elements. For example, a hybrid agreement may incorporate a residual airfield area and a compensatory terminal into its overall structure. Alternatively, a hybrid agreement could consist of an overall compensatory agreement between the airport operator and the air carriers, but the agreement may also include revenue sharing to help keep air carrier rates and charges at a fair and reasonable level (Faulhaber et al. 2010; FAA Airport Compliance Manual 2009).

Stakeholder Impacts. Integrating both residual and compensatory agreements, hybrid agreements attempt to balance the risk/reward relationship negotiated between the airport and air carriers. Because revenue sharing plays a significant role in hybrid agreements, air carriers can exert greater influence over airport capital improvement options than they would under a pure compensatory agreement.

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GRF Applicability. GRF savings would likely need to be shared to some degree with air carriers under a hybrid agreement lease structure because of the inclusion of residual agreement elements. Additionally, because air carriers may consider the allocation of savings generated in one cost center to another as an issue relating to "fairness of costs," an airport implementing a GRF could establish multiple GRF accounts for each cost center to avoid any conflicts under a hybrid agreement structure (Faulhaber et al. 2010).

Non-Agreement Approach. Although airport/airline use and lease agreements are the primary means by which airports set air carrier rates and charges, they are not the only means of doing so. A business arrangement between the airport operator and air carriers without a use agreement is generally referred to as an "ordinance" approach. In this case the local governing body for the airport can enact an ordinance establishing the terms and conditions under which the airport and air carriers will operate (Young and Wells 2004; Faulhaber et al. 2010).

Stakeholder Impacts. Air carrier influence over airport decision-making under a non-agreement approach is limited. Although an airport may have greater authority to operate its facilities as required by local ordinance, the lack of air carrier participation may weaken the relationship between the airport and airlines. Airports should also always keep in mind that they must comply with all federal and state laws when setting rates and charges under local ordinance.

GRF Applicability. Under a non-agreement approach, an airport may have limited barriers to GRF implementation; however, they may also have limited buy-in from air carriers serving the airport because of a potential lack of engagement. As major stakeholders of the airport, air carriers can help ease and expedite GRF implementation efforts. Airports benefit from air carrier engagement regardless of the airline's ability to influence an airport's capital and operational decisions.

Airport Concessions Agreements

Unlike airport/airline use and lease agreements (which are based on "cost-recovery"), concessions agreements allow airport operators to earn revenues based on the "market value" of space leased. Concessions, or nonaeronautical uses, are generally split into two areas: terminal concessions and landside concessions. Terminal concessions include food and beverage, news and gifts, and passenger services of various kinds. Landside concessions include parking facilities, rental car facilities, ground transportation services, advertising space, and in-flight catering (Vanden Oever et al. 2011).

Regarding leases between fixed-base operators (FBOs) and other tenants, these agreements generally should not limit the airport operator's ability to implement a GRF; however, airport operators must consider the various elements associated with FBOs and other airport tenant agreements. These include clearly defined leasehold areas, FBO and corporate tenant construction on leased areas, construction compliance with airport requirements, and maintenance responsibilities, among others (FAA Airport Compliance Manual 2009). In particular, airports must be very clear regarding whether their tenants have an ownership interest in real property or simply the right to conduct a particular activity (Vanden Oever et al. 2011). The degree of leasehold ownership may influence the level of control the airport operator has over tenant operations and will affect GRF implementation.

Standard Approach. Under the standard approach, the airport operator directly leases and manages concessions space. The airport assumes all financial risks and benefits from a larger portion of nonaeronautical revenue (American Association of Airport Executives 2014).

Stakeholder Impacts. Under the standard approach, concessionaires are bound to the terms set by the airport operator. To the airport operator, these terms should help maximize revenue generation and achieve self-sufficiency; however, concessionaires may view airport operator revenue maximization as a burden on their ability to provide the highest level of service as a result of decreased profit margins (American Association of Airport Executives 2014).

GRF Applicability. An airport operator with the greatest level of control over concessions operations will likely have the best ability to implement GRF projects as they apply to non-aeronautical leaseholds. With direct oversight, airport operators can more easily engage with concessionaires and determine the best opportunities to improve leasehold efficiency.

Development Company and Institutional Operator Approach. Airport operators with less concessions expertise can also contract management services out to a development company or retail experts. In this scenario, airport operators can reduce their risk by allocating the responsibility of managing some or all the concessions to a third-party operator.

Stakeholder Impacts. The advantage of outsourcing concessions management from the standpoint of concessionaires is the benefit that experienced management brings to nonairline operations. Experienced concessions managers can centralize resources across multiple operations (American Association of Airport Executives 2014). From the standpoint of airport operators, however, this option reduces control over concessions leasehold space.

GRF Applicability. Reduced airport operator oversight of concessions operations may limit the ability to implement GRF projects in nonairline leasehold areas. In scenarios where third-party operators are used to manage concessions operations, it may take longer to implement GRF projects because of the indirect administrative structure of the concessions agreement. Third parties could be incentivized to prioritize GRF implementation to achieve alignment with airport goals.

3.2 Step 2: Select a GRF Model


SELECT A GRF MODEL

Early in the fund development process, outline a tentative basic structure and mission for the fund. GRFs have a variety of elements that can be adapted to the unique challenges, opportunities, and priorities of each individual airport. There are no established rules for how a GRF must be structured, and new innovations are possible. Chapter 1 provides specific guidance and decision points for each component of a GRF.

Fund design should be an iterative and interactive process. It is often helpful to begin with a concept proposal, which can serve as a point of discussion with stakeholders as the airport seeks their feedback. This may take the form of a document, presentation, or a few talking points. Engage key stakeholders with this proposal early and often, being sure to include facility and energy managers, sustainability directors, and staff in charge of operations and

finance. The goal of this initial round of discussions is to identify logistical, political, and financial barriers to a GRF; develop a strategy for overcoming these barriers; lay the groundwork for building future support; and refine the proposed fund's structure to capture opportunities at each individual airport.

The following are two major decision points at this stage:

1. How will the fund be capitalized?
2. How will the fund be operated?

The following subsections present a series of models for fund capitalization and subsequent operation. Models for fund capitalization and operations can be mixed and matched to meet an airport's individual circumstances.

3.2.1 Initial GRF Capitalization Models

There are two approaches for capitalizing a GRF, and the approach chosen will determine the types of funding sources that can be used. The **endowment model** approach to capitalization requires a pool of available upfront capital to start but can make efficiency investments immediately. The **savings reclamation model** involves waiting for funding from operational savings before sufficient resources can be made available for new projects.

Endowment Model

The first approach is a traditional endowment model, where an amount of funding is dedicated for the express purpose of capitalizing a GRF. The benefit of this approach is that the fund is immediately able to finance new projects. The drawback is that a suitable source of funding must be identified, typically one that does not need to be repaid and is compatible with a GRF (see Figure 5).

Savings Reclamation Model

The second approach, known as a savings reclamation model, starts with a project (already identified and either being implemented or soon to be implemented) that will result in operational cost savings. The project owner then captures the resulting cost savings and uses those savings to capitalize the GRF. To the extent that such cost savings are related to expenses allocated to airline rates and charges as described in Section 3.1.5, the airport would capture only its share of cost savings for the GRF. Or, if the airport/airline use and lease agreement grants flexibility to maximize retained savings, an airport should seek airline consent to capture and retain 100% of the cost savings generated by a GRF. Depending on the airport/airline use and lease agreement and rate methodology, the airport should seek airline consent to capture 100% of cost savings for the GRF. The benefit of this model is that the funding used to implement the target project does not need to be earmarked for the GRF itself, because the resulting savings capitalize the GRF. For this approach to work, however, the GRF processes to capture and retain the savings must be in place, and all stakeholders must agree to use the operational savings in this manner. Fund capitalization is slower with this approach. The savings reclamation model can also be used with projects that generate new revenue (e.g., solar panel array), not just cost savings (see Figure 6).

Figure 5. GRF capitalization: endowment model.

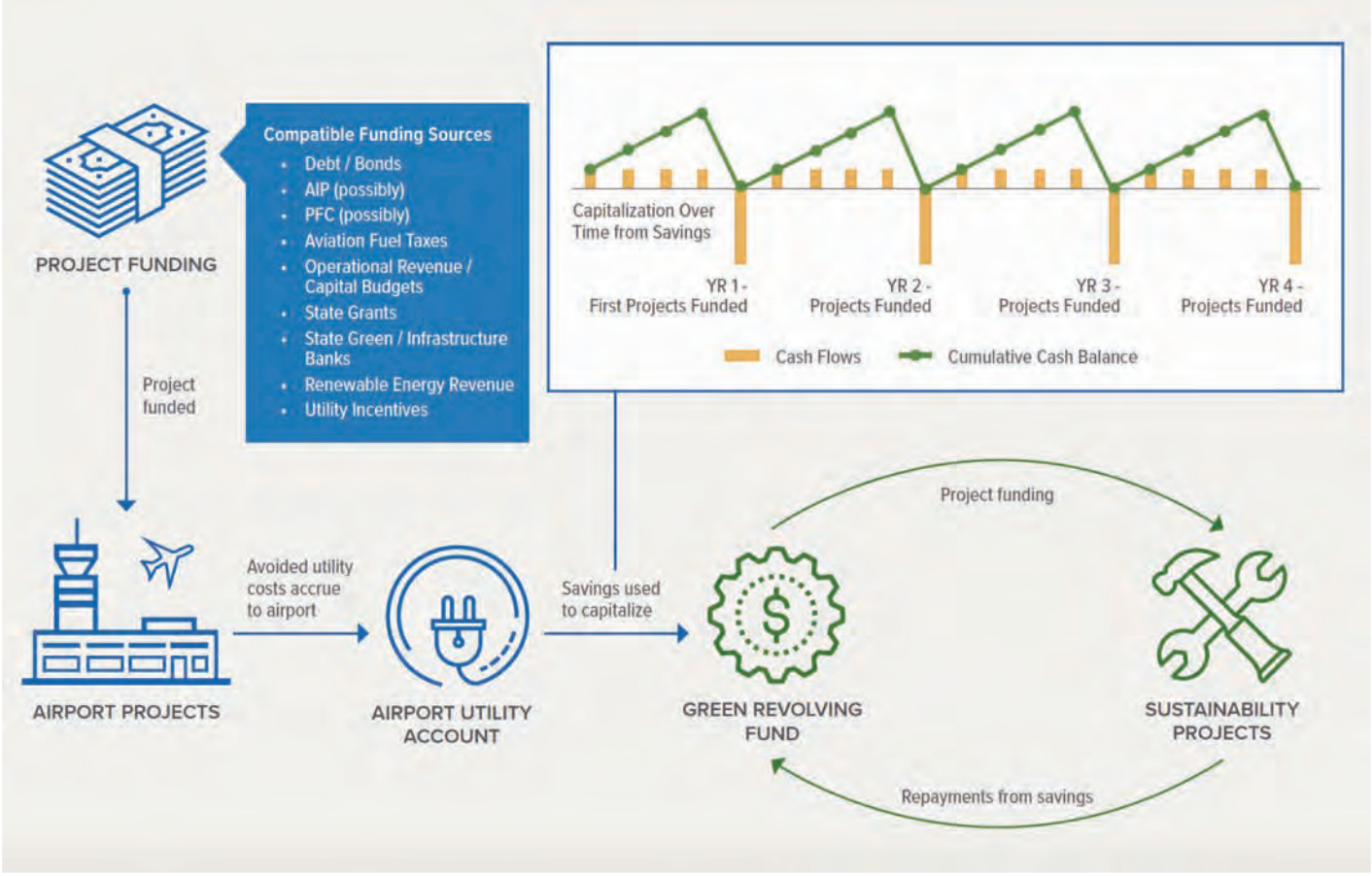
A savings reclamation model is often easier to implement because it can indirectly leverage federal, state, and internal capital budget funds that might not be eligible for use as an endowment.

3.2.2 GRF Operation Models

Once capitalized, there are various approaches for operating a GRF, ranging from relatively simple to complex. The best operational model is the one that aligns well with an airport's resources and structure, meets the intended goal of the GRF, and achieves broad stakeholder buy-in. Four operational models can be used as starting points and are outlined as follows:

Internal GRF Operation

The internal GRF operational model is the simplest GRF structure. It works only in situations where both the funded projects and the resulting operational savings are all internal to the same organization that runs and manages the GRF. For example, an airport forms a GRF that invests



AIP: Airport Improvement Program.
PFC: Passenger facility charge.

Figure 6. GRF capitalization: savings reclamation model.

only in airport (non-shared) facilities where the airport itself (not a lessee) is responsible for 100% of the operations and utility costs. In such a situation, the GRF "loan," the operational savings, and the repayments are moved from one internal account to another. This eliminates the need for more complex and time-consuming legal and administrative functions (like the creation and execution of lending agreements) found in other models.

The internal operational model consists of a GRF management team or committee that is typically made up of employees of the airport who either volunteer or are staffed part time on GRF operations. The GRF management team is responsible for identifying potential project ideas with input from airport departments, evaluating them, and approving them for funding. After projects are approved, funding is released from an internal GRF budget account—likely structured similarly to a capital budget account—to fund the project. When the project is complete, operational savings (e.g., from a reduction in an airport's utility budget expenditures) are used to repay the GRF, either through regular transfers of a predetermined

Figure 7. Airport GRF internal operation.

amount or based on actual accrued savings. Once the GRF has been repaid, the transfers are discontinued and the process repeats. Please note that use of savings from operating budgets may require the annual or bi-annual approval of either legislators, airport commissions, or other governing bodies.

The internal model is the simplest to implement, because it requires only internal stakeholder approval and minimal legal and administrative overhead (see Figure 7). The drawback of the internal model is that GRF investments are restricted to those that do not involve an external third party.

External GRF Operation

The external GRF operational model is designed to invest in projects outside the airport organization itself. For example, an external GRF might target sustainability projects in airline owned and operated assets. In an external GRF model, project ideas must be sourced from outside of the GRF itself, often through an application process. Funds are also lent to an external airport third party and repayment is more formal and structured than in an internal model. This requires additional investment in processes, forms, agreements, and performance tracking, but it allows the GRF to invest in a broader variety of projects than those available internally (see Figure 8).

The external operational model consists of a GRF management team or committee that is typically made up of employees of the airport who either volunteer or are staffed part time on GRF operations. The GRF management team is responsible for promoting and raising

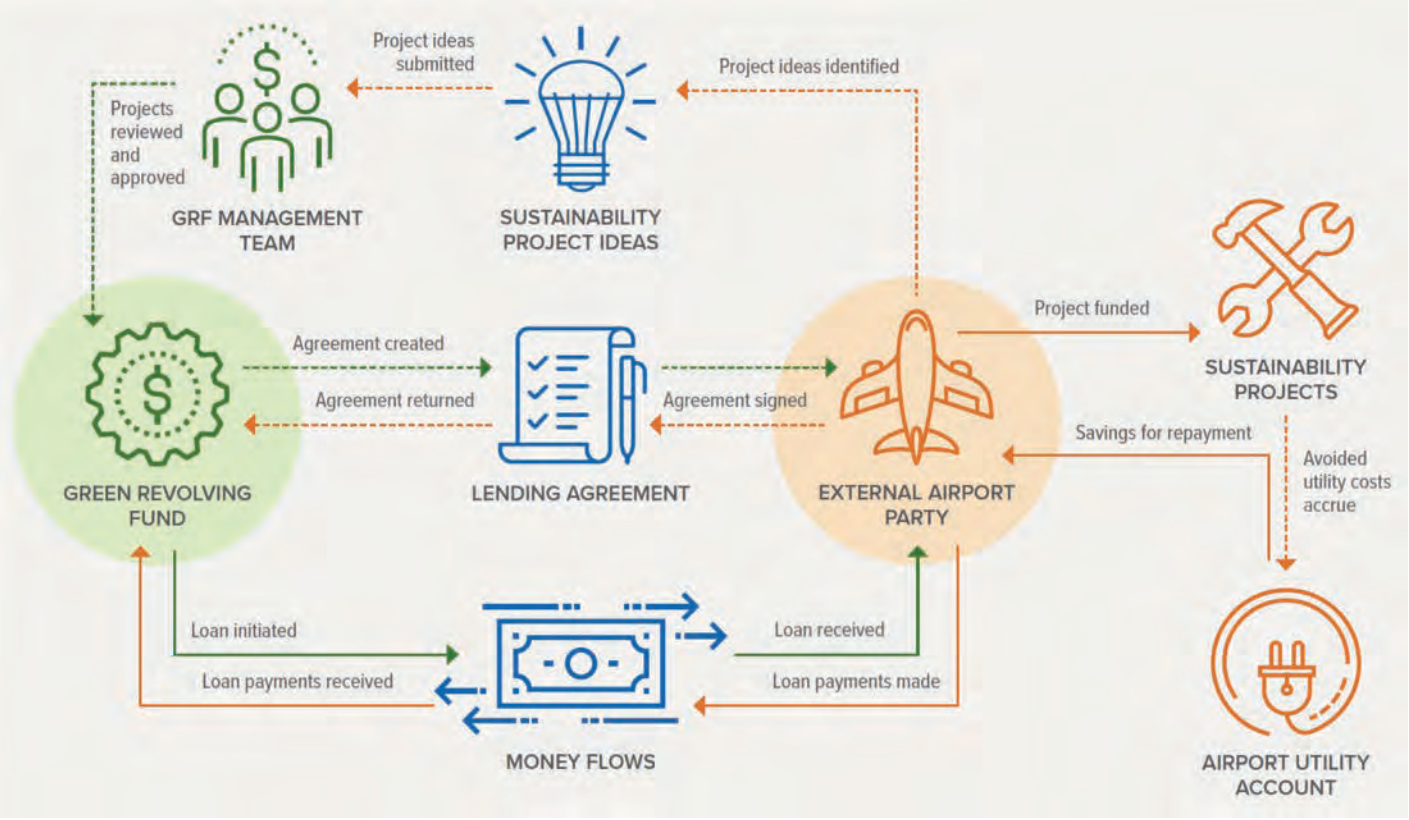


Figure 8. Airport GRF external operation.

awareness of the GRF among external airport parties and sourcing potential project ideas from external parties, often through an application submission and review process. The management team then evaluates and approves project applications. After approval, the GRF and the external party typically enter into some form of lending agreement that defines the project, the implementation schedule, and the terms of the loan including repayment and default procedures. Once the agreement is in place, funding is released from an internal GRF account to the external party pursuant to the terms of the agreement. After the project is complete, the GRF sends bills to and processes payments from the external party until the loan is repaid.

Hybrid Internal External GRF Operation

The hybrid GRF operational model combines the internal and external models, sourcing project ideas from both groups and implementing processes to approve, lend, and receive repayments from both (see Figure 9).

It is not uncommon for a GRF to start as an internally focused fund and add external investment capability as the fund matures and grows in size and sophistication. That evolution may be well suited to airports that begin with a focus exclusively on airport operated spaces and then expand the GRF to cover tenant areas after gaining experience with the approach.

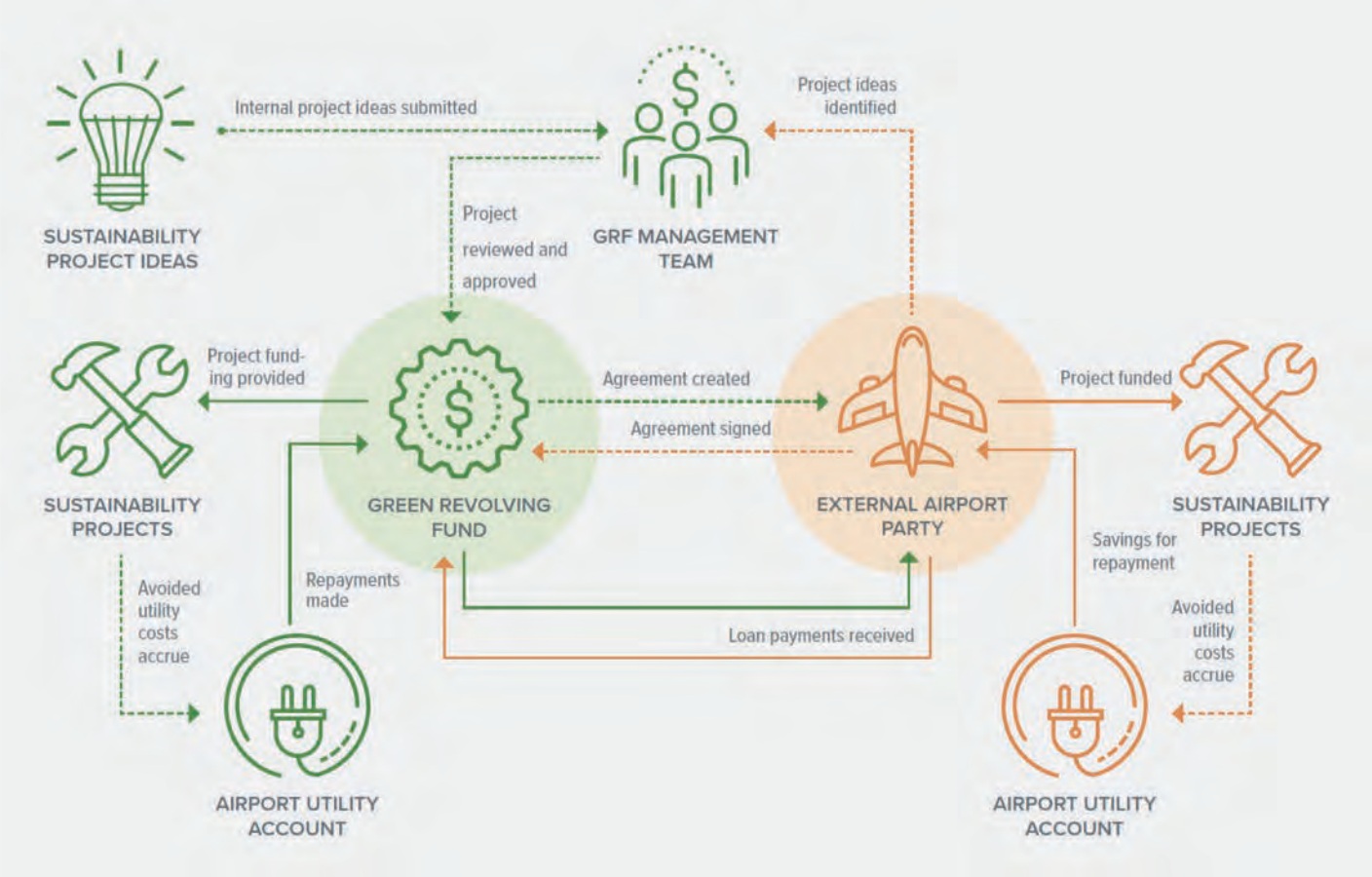


Figure 9. Airport GRF hybrid operation.

Rate-Base Recovery GRF Operation

A rate-base recovery GRF model is a specialized form of an external GRF operations model that uses the existing airport lease rate-setting process as the mechanism for repayment. A rate-base recovery model functions in a similar manner to the external model in all respects except, instead of using a separate lending agreement and processing external repayments, the lease outlines the provisions for accessing GRF funding and for the subsequent rate adjustments to cover recapitalization of the fund. Under this option, leases are adjusted based on the utility cost savings, and airports incentivize tenants' efficiency actions (see Figure 10).

The rate-base recovery model could be combined with an internal model to produce a hybrid internal/external fund.

3.2.3 Regulatory and Other Factors to Consider

If an airport is federally obligated, federal law requires that airport revenue be used for airport-related purposes. Revenue use restriction regarding FAA funding will apply to any of

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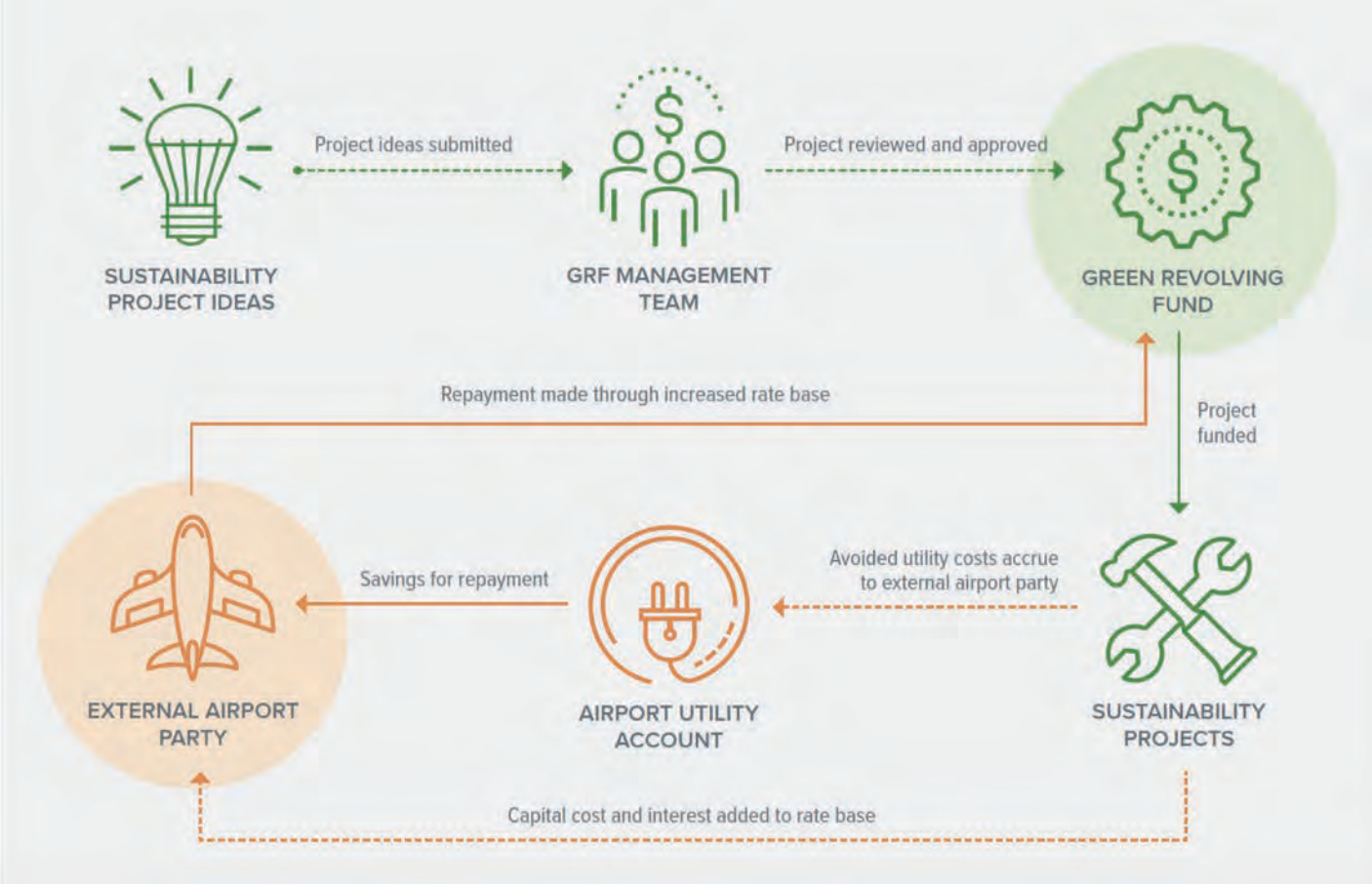

Figure 10. Airport GRF rate-base recovery operation.

the operational models outlined. (See the FAQ in Appendix A for additional information on revenue use limitations within the GRF context).

ASSESS INVESTMENT POTENTIAL

3.3 Step 3: Assess Investment Potential

To implement a successful GRF, it is important to first assess the investment potential at each airport. This can be done by in-house facilities staff who may already have a list of potential projects, or by hiring a contractor to perform an energy audit.

Planning and assessing potential projects will help create a pipeline of projects the GRF can finance during the first few investment cycles, including estimates of the costs and savings associated with each, and a forecast of how the portfolio of projects will perform. Forecasting the fund's expected performance over the first few years—including metrics like total savings, annual ROI, average payback period, and net present value (NPV)—is also helpful for building buy-in and tailoring the airport funding model to maximize performance.

Forecasting can be done using custom-made spreadsheets or specialized GRF tracking tools, which can also be used for tracking once the fund is launched (see Appendix D for more information). Investment cycles can be designated for any span of time; however, it is common to use 1 year.

3.4 Step 4: Engage Stakeholders and Build Buy-In

ENGAGE STAKEHOLDERS / BUILD BUY-IN

Identifying Stakeholders

A key component of developing a successful GRF is thorough stakeholder engagement. First, determine the essential stakeholders and decision-makers whose support will be required to establish and sustain a GRF. Second, consider those stakeholders' responsibilities at the airport, the performance metrics on which they are evaluated, and how a GRF can be leveraged to help them meet their goals.

Mobilizing Stakeholders

Engage identified stakeholders to refine the GRF proposal so that it is in line with the needs and goals of all parties. A written proposal—building from the concept proposal in Step 2—can be a helpful tool during this process. This document can facilitate discussion and debate as the GRF concept moves forward, and in many cases, it can evolve into the fund charter once the proposal is approved. Building buy-in and a sense of collective ownership should be a continuous process that occurs along with all the other steps; however, it is particularly important in the early stages to streamline the fund's development and ensure that stakeholder inconvenience is minimized and that all parties are invited to the table.

Should the Word "Green" Be Used to Describe Revolving Funds?

In some locations, the term "green" carries negative connotations. Implementers should consider whether the full name "green revolving fund" will present a barrier at their airport. While GRFs are more widely recognized by including green in their titles, an acceptable solution to addressing strong opposition to environmentally influenced decisions is to focus on the revolving and infrastructure qualities. An airport could adopt the alternative terms infrastructure revolving fund (IRF) or reclaimed savings for infrastructure (RSI) if the alternative name enables the new effort to be viable.

3.4.1 Airline Partnership Considerations

Prior to launching a GRF, develop the financial framework for the treatment of investments to be funded by the GRF and the treatment of expense savings associated with those projects. The traditional airport-airline relationship defined in airport/airline use and lease agreements focuses on the recovery of allocated costs (operating and capital) and may create barriers to the implementation of a GRF. For example, with utility conservation projects, split incentives can result when the airlines, as the party that pays the resource bills—and thus realizes the benefits of efficiency upgrades—are not the owners of the building. Airports can maximize the probability of GRF success by following the suggestions in this section.

Understanding Split Incentives

With split incentives, the tenant that pays the bills often will not want to invest in permanent improvements to a property it does not own, and the owner does not want to invest in improvements that only or primarily benefit the tenant. This same dynamic often pertains to airport

facilities. In some cases, an airport's ability to recover the capital investment costs funded by the GRF may be limited or may not match the time horizon needed to replenish the GRF. Further, even if an airport can amortize the capital costs in terminal rentals to generate a recovery, the utility savings will likely be passed on to the terminal tenants rather than shared with the airport. Split incentives create structural challenges to achieving the highest levels of energy efficiency.

In other cases, a partial split incentives situation exists in which an airline and airport share operational costs. This situation can complicate GRF investment if there is no agreement amongst parties regarding how savings will be used to repay the fund. **Agreements need to be in place before GRF projects are pursued**.

Overcoming Split Incentives Through Mutual Investment

Overcoming split incentives requires a mutually agreed upon approach to handling GRF investment and revolving savings to the fund. This requires negotiation between the airport and the airlines and possible amendments to lease agreements to reflect the allocation and distribution of energy savings. For example, consumption performance targets can be pre-established based on historical metering or modeling data. Achieving efficiency gains above the identified level specified in the rate base can generate additional revenue split between the GRF and direct reimbursement to airlines.

The following are a few revolving fund savings structures that airport and airlines could consider:

- **100% of operational savings reinvested.** This structure is the most favorable for maximizing GRF growth and scale of investments; however, it may be the least appealing to carriers.
- **100% of savings reinvested until project reaches an agreed upon payback status.** If all the revenue can be redirected to the GRF for the payback, the fund will maintain healthy recapitalization. After full payback is reached the airport and airlines can shift to a previously pre-negotiated acceptable ratio split for projects that continue to generate savings.
- **Portion of savings covers the airport's administrative investment first.** The administrative investment refers to the total value of employee labor hours that an airport dedicates to GRF planning, implementation, and continuous management. Airlines could equip airports to provide ongoing support to maintain the GRF with an acceptable portion of savings revenue (e.g., 10% of the total). After the administrative fees have been covered, the airport could split revenue at a mutually pre-established ratio with the airlines.
- **Rate-base recovery model.** Under this structure, airports can adjust lease agreements with airlines and other major tenants to reflect the operational savings achieved through efficiency. Consumption performance targets can be pre-established based on historical metering or modeling data. Achieving efficiency gains above the identified level specified in the rate base can generate additional revenue split between the GRF and direct reimbursement to airlines.

3.4.2 Obtaining Airline Consent

Airlines may have limited familiarity with GRFs. Airports should anticipate that their airline partners will benefit from learning how the revolving fund functions and how to realize mutual benefits.

Airlines May Be Reluctant Initially

Because the majority of airline agreements require operational cost savings to be shared, securing airline buy-in is crucial for GRFs to work at airports. Clear communications with the airline contract and legal departments can help them recognize the strategic benefits that can be accomplished through a GRF. However, obtaining airline consent for this type of project can be challenging. Given the tight margins and high level of competition between carriers, airlines may be hesitant to implement anything that may impact financial performance. Airlines, and their trade associations, may also be hesitant to establish precedent where conventional shared savings approaches are disrupted.

Potential Collaboration Solutions

The following are six suggestions for an airport to generate consent from its airlines.

1. **Go to the largest airline first.** If the airport can get the leading carrier to agree to a GRF, its acceptance can influence the other airlines to follow suit. Airlines with the largest vulnerability to energy prices and power supply disruption will be quicker to appreciate infrastructure investments that can improve airport resilience and decrease the impact of escalating electricity prices. After securing initial interest from the largest carrier, an airport could host a GRF informational meeting with all the airlines and co-present the concept.
2. **Combine GRFs with broader sustainability goals.** Presenting the GRF as a solution to a mutual challenge will likely be better received than proposing it as an independent initiative.
3. **Introduce the concept as a revolving fund partnership.** Frame the conversation as an opportunity to collaborate to accelerate project implementation and advance sustainability. Early discussion can focus on the overall GRF system as a novel revenue source for projects that might not be implemented otherwise.
4. **Recruit airline representatives who have environmental responsibilities.** Because airline representatives from real property and legal offices may have a narrow focus on bottom line performance, it is suggested that communication start with the environmental affairs representatives. The environmental team can present the GRF plan to senior leadership, which could include strategy and public relations executives. Airline senior leaders may see benefits that the more financially focused lines of business overlook.
5. **Calculate and share the GHG benefits.** Airlines are acutely aware that there is a growing interest in reducing carbon emissions from every source. Recent Intergovernmental Panel on Climate Change (IPCC) scientific summary findings strongly urge all sectors to reduce GHG emissions rapidly to reduce long-term warming levels below 1.5 C. Many U.S. states and cities have independently acted to remain in the Paris Agreement via either the America's Pledge program or We're Still In Coalition. Aviation is one of the only industries that does not have targets to reduce total emissions before 2030. Airlines may be hesitant to adopt more ambitious GHG reduction goals, because their operations are already efficient relative to other sectors, and razor thin profit margins generate minimal funding for additional CO_2 abatement. Their reductions have been estimated to cost as much as $200/metric ton of CO_2 (Energy Transitions Commission 2018). Many GRF actions are already cost-effective without the value of carbon. Airports can offer the GRF as a way for airlines to reduce in-sector emissions at a fraction of the cost they would be via other methods. Airports can recognize

airlines for their carbon reduction partnerships if the carriers choose to support emissions reductions achieved through GRFs.

6. **Pursue additional sustainability co-benefits.** If climate benefits are not compelling enough by themselves, airports can present additional benefits from GRF projects to airlines. One chief benefit of GRF-related projects is increasing airport resilience. When airports reduce their electricity or liquid fuel demand, fewer alternative energy sources—such as renewables and battery storage—are needed to cover an airport's remaining energy needs. GRFs could directly fund the systems that are less susceptible to outages, such as fuel cells and improved power grid supply. GRFs may also be able to directly fund microgrid projects that can yield revenue sources, such as transactive capabilities to participate in demand response and time-of-use programs. Other GRF projects may directly or indirectly reduce air quality emissions, water consumption, and waste material.

CHAPTER 4

Phase 2: Implementation—GRF Activation Steps

Once the overall structure of the GRF has been selected and key stakeholders are secured, the airport is ready to determine financial systems and begin investment. Chapter 4 provides information on the next three steps of implementation, highlighted in Figure 11:

4.1 Step 5: Secure Seed Capital
4.2 Step 6: Establish Fund Governance and Procedures
4.3 Step 7: Launch the Fund

4.1 Step 5: Secure Seed Capital

SECURE SEED CAPITAL

4.1.1 Introduction to GRF Funding Requirements

The process of securing seed capital can range from a straightforward allocation of available funding to a laborious multi-month process of consulting decision-makers. It is therefore advisable to begin this effort early. The size of the GRF and the amount of capital to be raised should match the airport goals for the potential projects. Step 3 is crucial to determining an appropriate size for the fund.

A GRF needs two types of funding to operate successfully. The first is **seed capital**. Seed capital is the money that will be invested in airport projects. The second is **operational capital**. This is the funding that will cover the operating expenses of the fund itself. Many of the potential funding sources discussed herein can be used to meet both needs, but some are only compatible with one or the other. It is worth noting that many GRFs have minimal operational capital needs, because they are administered either part time or by existing staff without hiring new employees.

4.1.2 Potential GRF Funding Sources

Seed and operational capital for a GRF can be obtained from a variety of sources. These examples constitute some of the potential funding sources available to airports for funding a GRF. They have been evaluated for ease of access, compatibility with GRF models, and scalability, and they have been arranged in three groups based on their likelihood to work for the majority

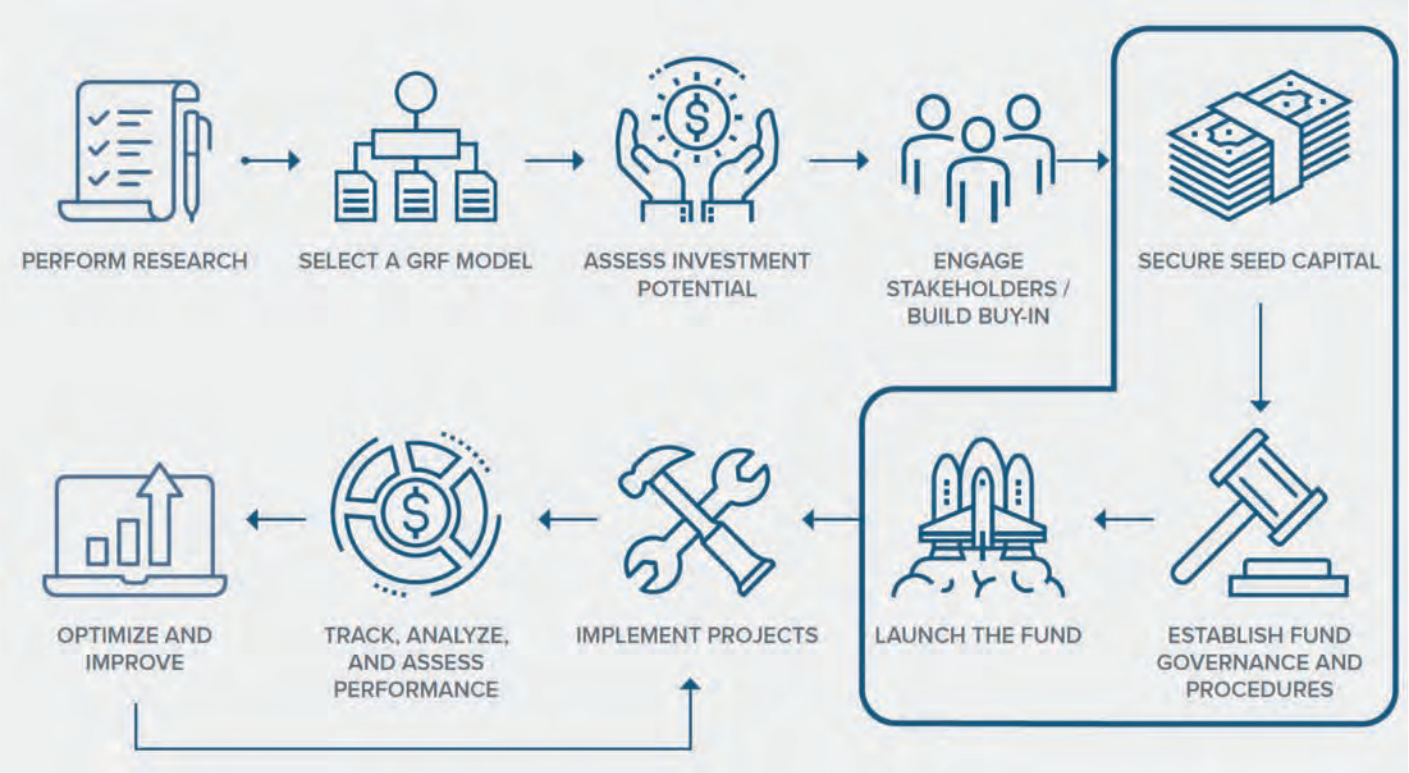

Figure 11. Phase 2: Implementation—GRF activation steps.

of the users of this report. A GRF is not limited to using a single source of capital, and airports can mix and match sources based on their individual circumstances.

Airport Revenue	
FUNDING TYPE	Internal
COMPATIBLE AIRPORT TYPES	All
CAPITAL USES	Seed and Operational Capital
COMPATIBLE GRF MODELS	Endowment or Savings Reclamation
AVAILABILITY	National
EE/RE ALLOWED	Yes

Tier 1 Options

The funding sources in this group are the most universally compatible with the GRF models and easiest to access. Airports should consider these options first.

Airport Revenue. Airports generate revenue through a variety of sources, typically broken down into airline (cost-recovery) revenue and nonairline (market-rate) revenue. Cost-recovery revenue comes from airlines for airport-provided services and shared services. Market-rate revenue is nonairline-related revenue from sources such as parking operations, car rental, concessions, advertising programs, and sponsorship opportunities. Both revenue sources could serve as potential seed or operational capital for a GRF. If an airport is federally obligated, federal law requires that airport revenue be used for airport-related purposes. (See the FAQ in Appendix A for additional details on the

revenue use limitations within a GRF.) Airport lease structures may constrain the use of cost-recovery revenue for a GRF, as described in Section 3.1.3. Airports have more flexibility in setting prices for market-rate services, which may make this a more attractive option.

Operating Budgets. Airport operating budgets are one of the most easily accessible funding sources for capitalizing and operating a GRF. Operating budgets can be used to fund a GRF through either a one-time endowment or a recurring budgetary line item. Because the savings associated with commonly funded sustainability projects, like EE/RE, typically accrue to the operating budget, using the operating budget to fund a GRF simplifies accounting and tracking. One way to fund a GRF without impacting the existing operating budget is to direct operational savings—such as utility bill savings after the installation of LED lighting—that would have accrued as a budget surplus to a GRF instead. Airports can likely program operating funds via their budget procedures for a GRF, especially given that cost savings (from operational sources) are the funding mechanism. It is also suggested that airports consult with municipal budgeting staff to determine how GRFs could function within generally accepted accounting principles (GAAP), if applicable.

Capital Budgets. Airport capital budgets are used to make long-term investments in buildings and equipment. The goals of the capital budgeting process are well aligned with those of a GRF, especially where energy efficiency and sustainability considerations are already part of the existing capital budgeting process. Because a GRF revolves over time and reinvests its funding in additional projects, the creation of a GRF can take pressure off future capital budgets by funding projects that would have otherwise been paid for from the capital budget. Funding contributions from capital budgets to a GRF can be structured as a one-time endowment or as a recurring budgetary line item. Similar to operating budgets, airports can likely program capital funds via their budget procedures for a GRF, especially given that cost savings (from operations) are the funding mechanism. It is also suggested that airports consult with municipal budgeting staff to determine how GRFs could function within GAAP, if applicable.

Bonds. There are four basic types of bonds issued to fund airport capital improvements including (1) general obligation bonds supported by the overall tax base of the issuing entity (the airport sponsor); (2) general airport revenue bonds (GARBs) secured by the revenues of the airport and other revenues as may be defined in the bond indenture; (3) bonds backed either solely by passenger facility charge (PFC) revenues or by PFC revenues and airport revenues generated by rentals, fees, and charges; and (4) special facility bonds backed solely

Operating Budgets

FUNDING TYPE	Internal
COMPATIBLE AIRPORT TYPES	All
CAPITAL USES	Seed and Operational Capital
COMPATIBLE GRF MODELS	Endowment or Savings Reclamation
AVAILABILITY	National
EE/RE ALLOWED	Yes

Capital Budgets

FUNDING TYPE	Internal
COMPATIBLE AIRPORT TYPES	All
CAPITAL USES	Seed and Operational Capital
COMPATIBLE GRF MODELS	Endowment or Savings Reclamation
AVAILABILITY	National
EE/RE ALLOWED	Yes

Bonds

FUNDING TYPE	Debt
COMPATIBLE AIRPORT TYPES	All
CAPITAL USES	Seed Capital
COMPATIBLE GRF MODELS	Endowment (limited) Savings Reclamation
AVAILABILITY	National
EE/RE ALLOWED	Yes

State and Local Taxes on Aviation Fuel

FUNDING TYPE	Fee / Tax
COMPATIBLE AIRPORT TYPES	All
CAPITAL USES	Seed and Operational Capital
COMPATIBLE GRF MODELS	Endowment or Savings Reclamation
AVAILABILITY	48 states. OH and TX excepted
EE/RE ALLOWED	Yes

by revenues from a specific facility. Bonds work well as a capital source for a GRF when paired with the savings-reclamation model but could also be used directly as seed capital for the GRF. If used to directly fund a GRF, interest rates charged by the GRF must exceed the interest rate of the bond, and internal GRF loan terms must not exceed bond terms, such that bond payments can be made from the pool of GRF repayments. A stand-alone bond issuance solely for the purpose of establishing a GRF is unlikely to be cost-effective, because there are relatively high fixed costs associated with a bond issuance. A better option would be a GRF carve-out on an already planned larger issuance. Using bonds to fund a GRF would impact debt load of an airport and, depending on the bond type, an airport's credit rating may impact cost.

State and Local Taxes on Aviation Fuel. State and local governments have the ability to levy aviation fuel taxes. Most states, with the exception of Ohio and Texas, have existing aviation fuel taxes. Federal law requires that aviation fuel taxes be used for airport-related purposes, if airports are participating in the Airport Improvement Program (AIP). Allowable uses of fuel taxes include capital and operating costs, such as improvements to airport systems and facilities owned/operated by the airport. Levying new fuel taxes or raising existing fuel taxes can be politically challenging because of the impact that fuel taxes have on airline operating costs, which makes re-allocating existing fuel tax proceeds a more attractive option.

Tier 2 Options

The funding sources in this group are also potential options, but may face some restrictions with respect to compatibility, ease of access, or availability.

Airport Improvement Program (AIP) Grants

FUNDING TYPE	Grant
COMPATIBLE AIRPORT TYPES	Public-use Airports in NPIAS
CAPITAL USES	Seed and Operational Capital
COMPATIBLE GRF MODELS	Savings Reclamation
AVAILABILITY	National
EE/RE ALLOWED	Yes

Airport Improvement Program Grants. The AIP is run by FAA under the U.S. DOT. Its broad objective is to help plan and develop a nationwide system of public-use airports that meets the current needs and the projected growth of civil aviation. AIP provides grants for a wide range of airport improvements including those that protect natural resources, which encompass energy efficiency and sustainability improvements. AIP grants are available nationally for all public-use airports in the NPIAS. Obtaining an AIP grant requires a grant application.

AIP funding is typically available for projects in four categories: Primary Entitlement Funding, Cargo Airport Entitlement Funding, Non-Primary Entitlement Funding, and Discretionary Funding.

- **Primary Entitlement Funding** is a subcategory of AIP apportioned to primary airports based on passenger traffic.
- **Cargo Airport Entitlement Funding** is a subcategory of AIP apportioned to cargo service airports based on cargo aircraft landed weight.
- **Non-Primary Entitlement Funding** is a subcategory of AIP specifically for GA airports listed in the latest published NPIAS that show needed airfield development.

- **Discretionary Funding** is a subcategory of AIP consisting of the money remaining after FAA apportions funds into its major entitlement categories. Discretionary funding's first priority is set-aside projects (airport noise and the Military Airport Program). After set-aside projects, funds are truly discretionary but distributed to projects that best carry out the purpose of the AIP, with highest priority given to safety, security, reconstruction, capacity, and standards.

In addition to these four categories, there are also AIP environmental grants to enhance air quality at airports. The Voluntary Airport Low Emissions Program (VALE) grant provides funding to cover the costs above routine replacement of equipment. Examples of eligible projects include upgraded boilers and gate electrification for aircraft. Zero Emission Vehicle (ZEV) grants offer airports a way to accelerate replacement of conventional internal combustion engine models with electric alternatives. Both types of grants could generate operational savings.

While AIP grants cannot be used to directly fund a GRF (see FAQ in Appendix A), they could be used in conjunction with the savings reclamation model. Under this structure an airport moves funding equal to achieved cost savings to the GRF, savings that have been made possible through an AIP funded project.

Passenger Facility Charges. The PFC program allows airports to collect a charge for enplaned passengers using the airport. Airports use this revenue to fund FAA-approved projects that enhance safety, security, or capacity; reduce noise; or increase air carrier competition. More than $2.2 billion in PFC revenues are collected by airport operators each year. PFC revenues are typically used on a "pay-as-you-go" basis, where PFC collections and interest earnings are spent directly on capital projects or leveraged (i.e., used to pay debt service on bonds or to repay other forms of debt).

To be eligible for the PFC program, a commercial airport must be controlled by a public agency and enplane a minimum of 2,500 passengers per year. Eligible agencies can apply to the FAA to collect PFCs up to $4.50 per enplaned passenger per flight segment. Air carriers collect PFCs specified by public agencies and remit those charges, less an FAA-specified handling fee, to the public agency for use on approved PFC-funded projects.

While PFCs cannot be used to directly fund a GRF (see FAQ in Appendix A), they could be used in conjunction with the savings reclamation model as described in the AIP section.

State Grants. Many states provide grants for airport capital improvement including EE/RE projects. Two resources airports can use to find state-specific opportunities include *ACRP Synthesis 24: Strategies and Financing Opportunities for Airport Environmental*

Passenger Facility Charges (PFCs)

FUNDING TYPE	Fee
COMPATIBLE AIRPORT TYPES	Commercial Airports Controlled by a Public Agency with >2,500 Passengers per year
CAPITAL USES	Seed and Operational Capital
COMPATIBLE GRF MODELS	Savings Reclamation
AVAILABILITY	National
EE/RE ALLOWED	Yes

State Grants

FUNDING TYPE	Grant
COMPATIBLE AIRPORT TYPES	Varies
CAPITAL USES	Seed and Operational Capital
COMPATIBLE GRF MODELS	Savings Reclamation and Possibly Endowment (Varies by State and Grant)
AVAILABILITY	State-by-State Basis
EE/RE ALLOWED	Yes

Programs (Molar 2011) (see the section on state funding opportunities) and the Database of State Incentives for Renewables & Efficiency (DSIRE) (n.d.). A grant-funded capital improvement project that results in operational savings would be a good match for a savings reclamation model. Some states may offer grants that could be used to directly fund a GRF.

Tier 3 Options

Tier 3 funding options are worth considering but may only generate modest amounts of revenue. Some of these more unconventional choices may be a solid fit for an airport, and others may not be applicable. Table 1 contains a summary matrix of choices.

Carbon Charge. A carbon charge is a fee used to cover the cost of carbon mitigation projects. A carbon charge could be used to fund a GRF, if the GRF prioritizes carbon mitigation. The Anti-Head Tax Act prohibits charging a fee on a per person basis (PFCs are an exception), so a carbon charge could only be negotiated on an air carrier basis. However, the current federal rates and charges policy prohibits airlines from paying for facilities until construction is complete, which limits the use of a charge for the endowment model. A carrier-based carbon charge used in conjunction with a savings reclamation approach could be a viable path.

State Green Banks. A green bank is a public, quasi-public, or independent private institution dedicated to financing the deployment of renewable energy, energy efficiency, and other clean energy and green infrastructure projects in partnership with private lenders. A number of states, including New York, Connecticut, California, Rhode Island, and Hawaii have green banks. Green banks could serve as a source of seed capital for project investment.

Mission Driven Investments. Charitable foundations are increasingly deploying their capital through mission driven investments (MDIs) that seek to earn a modest financial return while driving change in the area of focus for the foundation. Foundations with a focus on sustainability, energy efficiency, and renewable energy deployment may be willing to consider making an MDI as seed capital for a GRF.

Foundation Grants. Charitable foundations may also offer grants for sustainability, energy efficiency, and renewable energy deployment that could be used in conjunction with the savings reclamation model or the endowment model as seed capital for a GRF.

Self-Sustaining Funding for Ongoing GRF Operations. Managing a GRF requires staff to help identify and review potential projects, track investment performance, process revolving funding, and oversee general operations. Some funds are structured as part of an existing office or department, and existing staff take on managing a GRF as part of their regular duties. It is possible that a large airport GRF may warrant dedicated staff. In most cases, there is at least some ongoing cost associated with administering a GRF that must be covered through annual budget allocations or by earnings from the GRF itself.

There is also the possibility that projects may not perform as expected or that third parties may not fully repay the investment. To operate sustainably, a GRF must be able to replenish potential losses.

Table 1. GRF funding options summary.

	AIRPORT REVENUE	OPERATING BUDGETS	CAPITAL BUDGETS	BOND	STATE AVIATION FUEL TAX	AIP GRANTS	PFCS	STATE GRANTS
FUNDING TYPE	Internal	Internal	Internal	Debt	Fee / Tax	Grant	Fee / Tax	Grant
REPAYMENT REQUIRED	No	No	No	Yes	No	No	No	No
SUPPORTS EE/RE	Yes	Yes	Yes	Yes	Yes	Yes, limited	No	Varies
SUPPORTED AIRPORT TYPES	All	All	All	All	All	Public-use Airport in NPIAS	Commercial Airports Controlled by a Public Agency & >2,500 Passengers per Year	Varies
COMPATIBLE USES	Seed or Operating	Seed or Operating	Seed	Seed	Seed or Operating	Seed or Operating	Seed or Operating	Seed or Operating
COMPATIBLE GRF MODELS	Endowment or Savings Reclamation	Endowment or Savings Reclamation	Endowment or Savings Reclamation	Endowment or Savings Reclamation	Endowment or Savings Reclamation	Endowment or Savings Reclamation	Endowment or Savings Reclamation	Endowment or Savings Reclamation
AVAILABILITY	Nationally	Nationally	Nationally	Nationally	48 states, OH and TX excepted	Nationally	Nationally	Varies by State
REQUIREMENTS TO ACCESS	Internal Approval	Internal Approval	Internal Approval	Must Issue Bond or Add on to Bond Issuance	Approval of New Tax Issuance/ Reallocation of Existing	Grant Application + NPIAS	Application (FAA Form 5500-1) Authority to Impose/Use a Fee	Varies

Finally, GRFs often aim to grow over time to enable increasingly large investments in the future. Growth can occur by procuring additional seed capital from outside sources, from ongoing budget allocations, or from earnings from the GRF itself.

The following are three common mechanisms that operational GRFs employ to ensure a sustainable source of funding:

GRF Fees. Many GRFs charge a small administrative fee for processing an application or as part of funding a project.

GRF Interest. A GRF project investment can be structured as a loan with an interest rate and a regular monthly payment. Charging interest allows a GRF to cover operating costs potential losses, and to grow the fund over time. In cases where seed capital has been borrowed (such as a bond issuance), a minimum amount of interest may be required to pay back the providers of the seed capital. GRF interest rates should be competitive or uptake will be low.

Pay-It-Forward. Another method used to cover costs and grow a GRF is the pay-it-forward model. In this approach, projects are paid back over time through a series of set payments, often calculated to be equal to or slightly less than the monthly savings created by the project. These payments continue until the original investment amount has been repaid. At that point, the borrower makes a set number of additional payments that help grow the GRF. The number of these additional pay-it-forward payments is agreed upon with the borrower at the beginning of the process.

4.1.3 Choosing the Right GRF Funding Source

There is no right answer to selecting a funding source for a GRF. Each GRF is unique and faces a unique set of opportunities and challenges. Ultimately, the best funding sources are those that are (1) compatible with the GRF design and airport structure, (2) accessible, and (3) have minimal (or at least manageable) impacts on other stakeholders. This section describes each of these criteria in more detail.

It's also important to note that GRFs are not limited to using a single source of funding. Some GRFs use one source for initial capitalization and another to support ongoing operational expenses. Others find they need to "bootstrap" their way to success by starting with many small sources of capital to prove the concept before senior leadership is willing to make a larger investment. Whatever funding circumstances prove effective at a specific airport, flexibility and willingness to consider alternatives throughout the funding process will make the process run more smoothly (see Figure 12 for a visual summary of the options).

Compatibility

Size of Funding Source. In general, a larger fund is typically better than a smaller one, because it covers multiple capital needs at one time. Before searching for funding, determine how much the airport really needs. Assess the volume of projects that an airport could fund on an ongoing basis, the size of the typical investment, and how many projects the GRF management

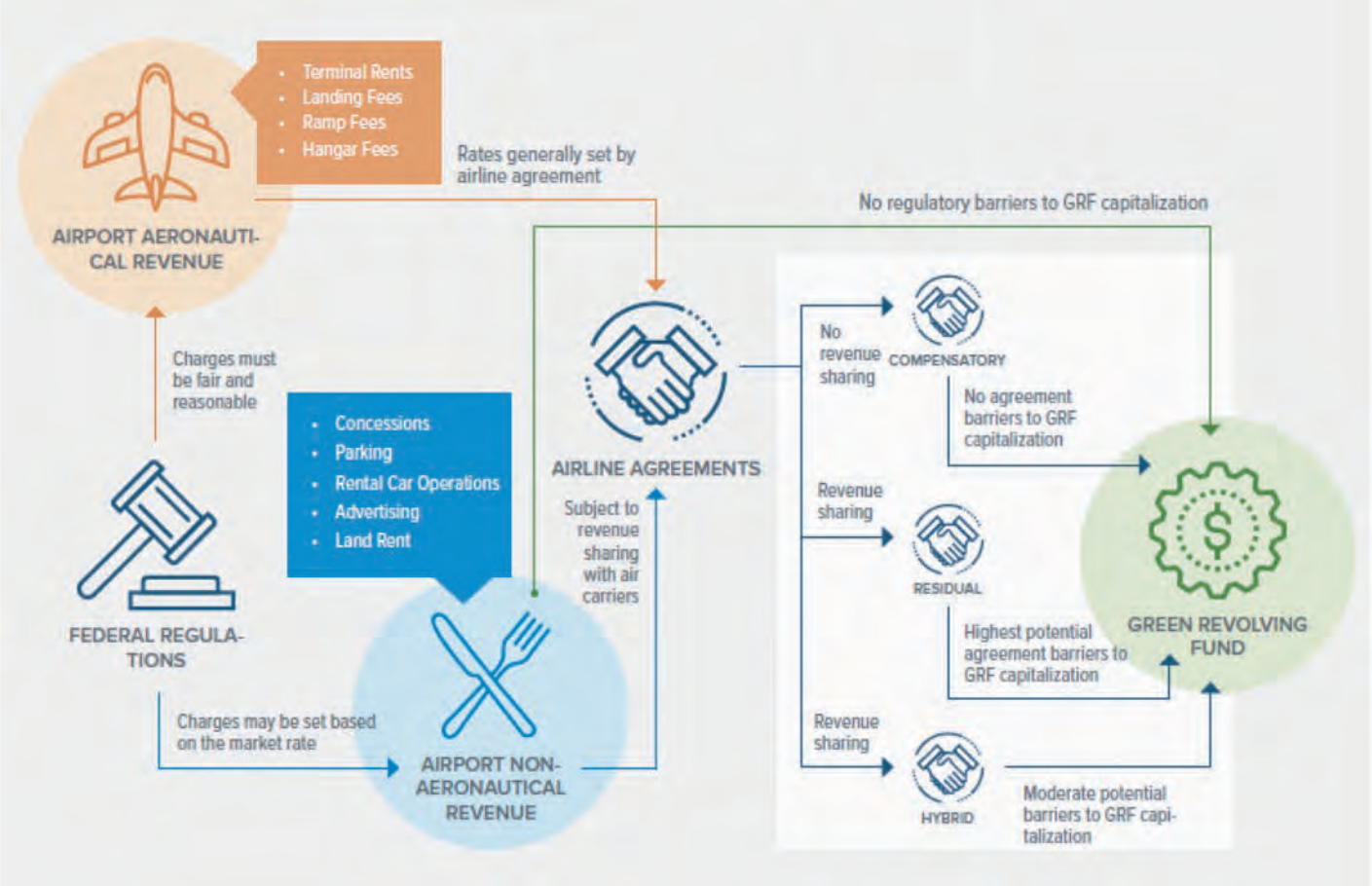

Figure 12. Airport revenue use for GRF capitalization.

team could realistically review and fund on an annual basis. Also consider the average term of project repayment, because that determines the amount of money that will revolve to the fund each year to be reinvested in new projects. If seed capital requirements cannot be satisfied from a single funding source, consider multiple options.

Repayment Requirements. Some potential capital sources—bond issuances, MDIs, or state green bank investments—come with repayment requirements. While these sources can be used as seed capital, they come with additional constraints. At a minimum, the interest rate and term of GRF investments must be managed to match the capital repayment requirements. If a 10-year term for GRF repayment is desired, but a potential capital source needs to be repaid in 5 years, look for other options or adjust the airport GRF goals.

Airport Type. Some funding sources are restricted to certain airport types—passenger, cargo, GA, public, private, and so forth—or only available to airports that participate in certain federal programs, such as NPIAS.

GRF Model. The savings reclamation model of capitalizing a GRF is compatible with any funding source. If there are plans to follow the endowment model of capitalization, this will eliminate a number of potential funding sources (e.g., AIP and PFCs).

Seed versus Operating Capital. The ultimate use of the funding source will also determine which sources are compatible. Sources of capital that need to be repaid, such as bonds and MDIs, should be used only as seed capital.

Ease of Access

Approval Required and Acquisition Process. Internal sources of funding, such as revenue, operating budgets, and capital budgets, are often the easiest to acquire, because they require only internal authorization. For external sources, gauge the airport team's ability to manage or coordinate the processes required to obtain funding. Grants require applications and often come with additional stipulations and reporting. Depending on the complexity of the application and availability of current staff, an airport may need to secure new personnel or leverage consultants. Bond issuances can be an involved process and may impact the credit rating and debt capacity of the airport. The use of PFCs and fuel taxes requires federal or state approval, respectively.

Availability. Some funding sources are available in only certain states, during certain timeframes, or as one-time sources with fluctuating availability. These may be better suited for seed capital. Look for steady funding sources for ongoing operational capital.

Familiarity. Some funding sources like internal budgets, bonds, AIP grants, and PFCs, are well established financing mechanisms in the air transportation industry. It may be easier to get internal buy-in around these funding sources, because they are well understood. However, for that same reason, they may also already be fully allocated to other projects. Explore new funding opportunities from unconventional sources, even if it may take more work to get support for their use.

Stakeholder Impacts

Another aspect of selecting a funding source is the potential impact it could have on various other stakeholders. As a general rule, the more stakeholders involved in the process, the more interests that need to be considered, and the harder it will likely be to secure funding. Consider the following stakeholder groups when reviewing potential funding sources:

- Internal airport staff
- Internal airport management
- Air carriers—especially where lease and cost-recovery might be an issue or fees may impact competitiveness of the airport
- New revenue sources potentially related to marketing or promotion
- FAA
- Existing bondholders (in the case of debt issuance)
- State and local governments

Lease Compatibility

Deployment of a GRF in airport leased space requires coordination with tenants. Ideally, an airport discusses a potential GRF with an airline or concessionaire as part of the contract negotiation process. Tenants need advance notification and adequate education to understand how a GRF would function as part of a potential lease. The suggested time to introduce the GRF concept is as part of the agenda for the first contract negotiation session. Introducing the possibility early will provide time to educate stakeholders and decide on implementation steps.

Modifying existing contracts to incorporate GRF provisions is not suggested, because of the challenge of educating stakeholders, securing their agreement, and refining the existing lease. Lease modifications require multiple months, or longer, to complete. If the rented space constitutes a major portion of the airport's total space, or if a current contract still has significant time remaining (4+ years), these factors may influence an airport's choice to initiate a contract modification. Airports considering a GRF for leased space should consider adding the action to the Master Plan, so that future changes are integrated into long-term decisions and preparation.

Incentivizing tenants with a reasonable cost savings split, or decreased rental rate, is the easiest way to obtain agreement and motivate airlines and concessionaires to participate. Adequate utility submetering is essential for monitoring performance in an individual leased space. If measurement of a specific space is not possible, the airport needs to determine if the magnitude of potential savings warrants investment in new metering. In general, the cost to install metering should be at least less than the 1 year's worth of utility cost savings achieved through a project. Airports will also need to negotiate with tenants over how measurement equipment costs will be covered by the parties.

4.2 Step 6: Establish Fund Governance and Procedures

ESTABLISH FUND GOVERNANCE AND PROCEDURES

4.2.1 Fund Oversight

The set of stakeholders tapped to oversee a GRF is another key consideration that affects both the politics of the fund and its performance. There are three options for selecting projects and managing the operations of a GRF (the details of management are described in Section 3.2.2):

- Management committees (or teams) are the most commonly adopted leadership structure for GRFs. Such a committee may be formed from a pre-existing body, such as a sustainability working group, or may be formed specifically for the GRF. Affected stakeholder groups should be represented on the committee to maintain buy-in and contribute expertise.
- Staff and resources from a relevant department may be used to oversee the fund—often the finance, operations and maintenance, or sustainability departments.
- A dedicated manager may be appointed specifically to run the fund, or fund management may be added to the job responsibilities of a current administrator.

Management by committee is often advantageous for several reasons. First, it leverages the unique breadth of expertise across the airport community. Second, it promotes engagement

and awareness of the fund. Third, it reduces the burden that falls on any one member of the committee. However, a smaller management team housed within a single department offers tighter control of financing and a more streamlined process for issuing loans.

In some cases, these leadership structures have been combined, with different groups managing different aspects of the fund. For example, a sustainability leader may serve as the fund manager and coordinate the operations of the fund, with a committee (sometimes chaired by the fund manager) that selects airport projects and provides guidance.

4.2.2 Establishing a Charter

The management of fund operations involves a broad array of duties. Official and publicly available GRF charters are suggested. This document should clearly explain how the fund operates. Charters are often developed from a written proposal used to facilitate discussion during the funding design stage and may use much of the same language (see the example included in Appendix E).

4.2.3 Setting up Financial Structure

All stakeholders should feel comfortable with the loan and repayment process. Before any project is undertaken, involved parties must understand the following:

- **Point of Contact.** Who pays the project invoice, which account is used, and when will those funds be available.
- **Repayment Process.** Which account will be used to make repayments over the course of the loan, how often those repayments occur, and the total of each repayment as well as the overall repayment obligation.
- **Accounting Requirements.** How will these flows of money appear on the various departmental budgets and balance sheets (if multiple departments are involved).

Establishing this internal accounting procedure is the point at which many GRF proposals stall or fail entirely, often because technical details are overlooked by fund proponents, or they encounter red tape. Be sure to begin engaging on this issue early in the process. Some airports might choose an independent account with its own ID number for a GRF, while others may simply make an agreement to acknowledge the savings of the GRF as annual budgets are distributed (see Appendix D). Examine how external purchases are made at the specific airport and how funds are transferred internally; then, base GRF payment flows on these pre-existing channels.

LAUNCH THE FUND

4.3 Step 7: Launch the Fund

When launching a GRF, it is useful to pre-plan the first round of funding. The insights from Step 3 will be useful to support advance planning. As projects are implemented, make sure to continue the planning process to address the next round of actions, fund management considerations, outreach activities, and leadership team meetings. Planning for the future is important

to efficiently manage the fund and to ensure that its capital remains effectively invested. Advance preparation also demonstrates positive momentum to airport stakeholders.

It is important to establish the GRF fund in a way that fits within the airport culture and administrative structure, specifically the following:

- Formalize the GRF with a fund charter, bylaws, memorandum of understanding, formal project criteria, and any other necessary guiding documents. Be sure that all relevant stakeholders are aware of these documents.
- Consider developing a website for the fund. This can provide a useful venue for informing the airport community about the fund, posting official fund documents, providing tools and resources for getting involved or proposing projects, and reporting on the fund's progress to the public.

Finally, when the fund is launched and the first few cycles of investment are underway, there are a few key questions to be evaluated, found in Section 5.3.2, to ensure that the fund runs smoothly.

CHAPTER 5

Phase 3: Operations—GRF Project Implementation and Ongoing Management

Once investments are being made and new equipment is in place, performance needs to be tracked. Managers of the GRF will need to monitor individual projects, and periodically assess how the entire GRF is functioning to make improvements as necessary. The steps associated with this operations phase, highlighted in Figure 13, are as follows:

5.1 Step 8: Implement Projects
5.2 Step 9: Track, Analyze, and Assess Performance
5.3 Step 10: Optimize and Improve

IMPLEMENT PROJECTS

5.1 Step 8: Implement Projects

5.1.1 Planning and the National Environmental Policy Act: Identifying Potential Projects and Environmental Requirements and Considerations

As with all actions at airports, projects must also comply with planning and environmental review requirements.

For planning, projects need to comply with the Airport Layout Plans (ALPs) and Master Plan documents. New projects that have already been approved in existing plans may not require additional planning consultation with the FAA. If actions do not change the airport current or future usage for a specific space or area, then it is less likely that the FAA will require revisions to the ALP before implementation. Any changes to the planned functional land or buildings will require revisions to the ALP and Master Plan. See the FAA Advisory Circular 150/5070-7 for more details regarding airport planning requirements.

All federal actions must follow procedures for the National Environmental Policy Act (NEPA). NEPA pertains to all federal actions that may create "significant" impacts. Federal actions are defined as projects that receive federal funding or occur on federal land and involve construction or management activities.

In the case of airports, projects that occur entirely within an existing developed "footprint" (e.g., replacing existing equipment) might not constitute a significant action. However, actions must be assessed to determine if they do not require extensive environmental analysis and can be exempted through the granting of a Categorical Exemption (CE). Revolving fund projects

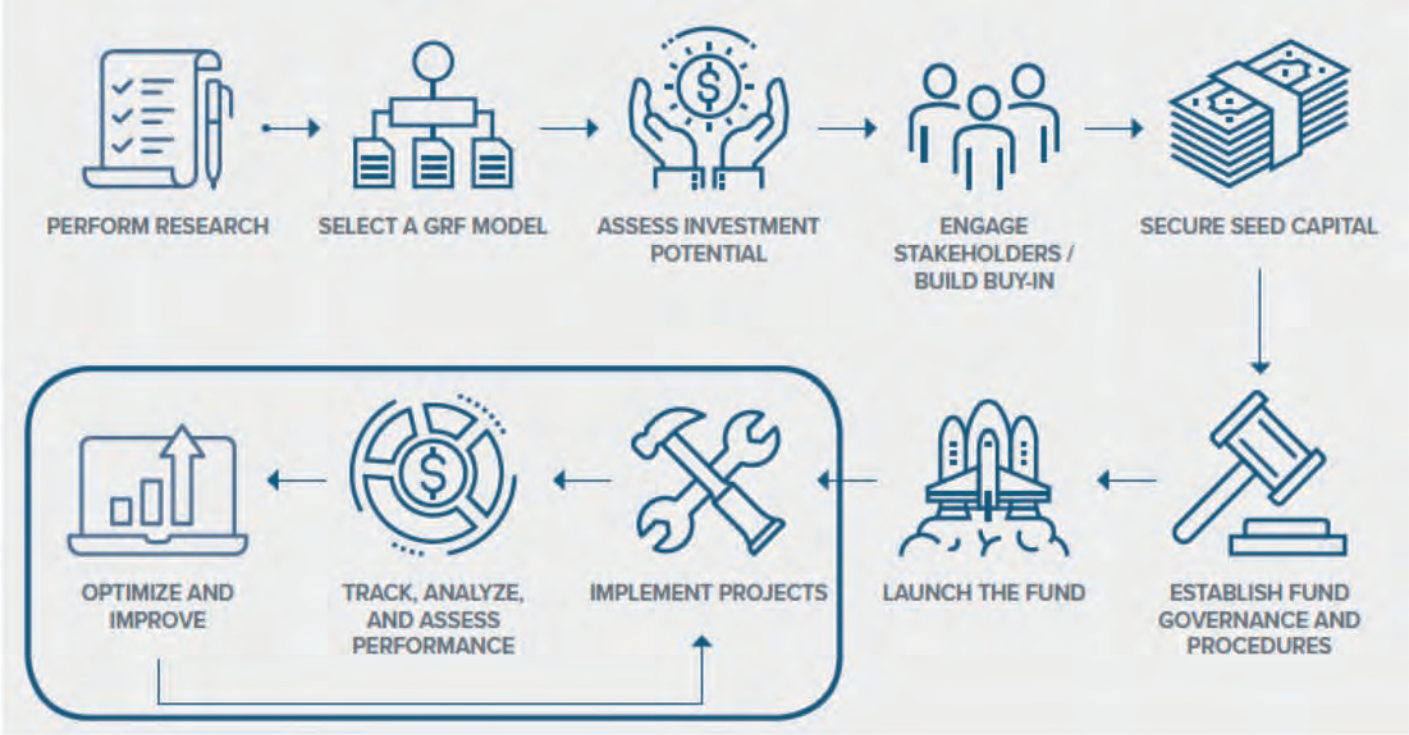

Figure 13. Phase 3: GRF operations—GRF project implementation and ongoing management.

that involve upgrading infrastructure that is already in place without any impacts to land (e.g., swapping out an indoor boiler unit) will likely fall under a CE designation. Projects that include construction impacts to undeveloped land (e.g., new ground-mounted solar installation), may trigger the more time intensive Environmental Assessments (EAs) or Environmental Impact Statements (EISs). The FAA's NEPA Implementing Instructions for Airport Actions (Order 5050.4B) provides additional support on this topic. In addition to federal requirements, airports must review and comply with relevant state and local environmental regulations.

If there is any uncertainty, it is suggested that airports consult with FAA designated planning and environment airport contacts for additional guidance regarding airport planning and NEPA requirements.

5.1.2 Prioritizing Project Opportunities

Project Selection

It is important for airports to clearly specify their procedure for reviewing, evaluating, and selecting GRF projects. Fund managers may select projects non-competitively or put out an open call for proposals to all airport staff. For example, they may compile a prioritized list of potential projects identified via an energy audit and select projects from this list. If using this approach, it is advisable to have a representative from the airport's operations and maintenance department either on the management committee or in close contact with the committee to

streamline this process. Projects may also be identified from previously existing lists, such as a deferred maintenance list.

Project Criteria

When assessing potential projects, it is helpful for fund managers to work from a specific set of project criteria. These criteria may include both hard requirements and preferred attributes. Some common project criteria include the following:

- Payback duration
- Capital required
- Specific environmental benefits such as resource conservation or GHG reduction
- Cost-effectiveness metrics such as GHG reduction per dollar of capital invested
- Potential for community engagement and collaboration
- Educational benefits

Project criteria should be selected based on two factors. First, they should promote the mission of the fund. A GRF that is focused on maximizing operational efficiency might have aggressive payback requirements. Second, criteria should be tailored to the actual portfolio of projects that are available for investment.

Consider incorporating flexibility in project requirements at the discretion of the fund managers. They may need to adapt as the portfolio of available projects changes over time or as unique opportunities arise. In addition to specific criteria, projects should also be prioritized in a way that best allocates limited resources while accounting for the feasibility and timing of projects given other constraints, such as staff availability.

5.1.3 Implementing Projects

Implementing the initial round of projects will inevitably lead to challenges and unexpected obstacles. There may be difficulties with fund transfers and accounting, changes in maintenance plans that disrupt an anticipated project pipeline, projects that underperform once implemented, and other potential issues. See the FAQs in Appendix A regarding specific challenges often encountered and strategies for overcoming them.

One approach to reduce these risks is a soft launch in which the first round of investment targets prioritizes projects that are expected to be straightforward and implements them with trusted project managers.

Keeping stakeholders informed about likely obstacles and recognizing how those obstacles are handled will set the tone for future operations. Be sure to include all relevant airport stakeholders in the troubleshooting process. Despite the pressure to produce successes and prove the GRF model, work through challenges carefully taking as much time as necessary. Publicize successful projects to place any challenges in the context of the broader GRF program and continue to justify the use of capital for the fund.

Fund managers should be in close contact with the facility managers, engineers, or contractors who implement the projects and can therefore provide on-the-ground perspective. This will allow problems to be identified and resolved effectively. Monthly or quarterly progress reports may be useful for this purpose.

5.2 Step 9: Track, Analyze, and Assess Performance

Once the fund is operating, tracking the performance of individual projects and the entire GRF portfolio over time is the next important step.

First, determine the selected method to be used to measure savings from individual projects (see Appendix D). Airports may decide to measure energy savings [e.g., kilowatt hours (kWh) or therms] instead of cost reduction, given price fluctuations for electricity and fuel. Next, install any required submeters and establish baseline data before project implementation, then create a spreadsheet or use a web platform to manage this data over time, see Appendix D, Part 2. Thorough project tracking will involve recording the specifications of technology installed and estimating expected savings; comparing those estimates with usage rates determined early on via energy monitoring to ensure that projects are operating correctly; and confirming savings conclusively by comparing submetered data with the baseline the airport has established.

Note that even if an airport determines project repayments based on estimated savings only, conducting some measurement and verification (M&V) of individual projects will confirm that they are operating as expected. Find a balance between what is necessary for project trouble-shooting and determining payback, and what is feasible given staff capacity and budget.

Second, develop a system for tracking and analyzing the overall activity of the airport's GRF project portfolio. Airports can also use spreadsheets built from scratch, specialty GRF software, or accounting software for this purpose. Verify that overall GRF performance is consistent with the forecasts conducted in Step 3. If there is a discrepancy, determine its cause. It is often helpful to conduct forecasts that are updated each year to chart a path forward for the fund and manage expectations.

It is also advisable to benchmark the performance of projects, buildings, and the fund against those of other airports. In cases where the projects perform below original estimates, take the opportunity to identify the underlying causes and learn from peer airports.

The GRF model relies on capturing cost savings to replenish the fund, so the method by which those savings are measured is crucial. There are two main strategies that fund managers may use to calculate savings from projects to determine repayment amounts.

First, fund managers may use front-end savings estimates based on engineering analysis. This method relies on technology specifications and assumed usage patterns to predict future performance. This is the most straightforward and inexpensive approach, but it will not capture any deviations in the event that a project performs better or worse than expected.

Second, fund managers may retroactively calculate savings based on actual performance. This entails using an M&V approach to directly meter savings while accounting for conflating factors like weather and usage patterns. This approach is more accurate but also costlier and more labor-intensive (see Appendix D).

An airport may perform rigorous building energy modeling based on submetering data, or it may measure pieces of equipment individually and extrapolate for the full set of equipment installed. Another option is to conduct a less rigorous assessment of whether utility costs are decreasing over time. This will not be sufficient to calculate project repayments, but it can help verify that a project or portfolio of projects is decreasing costs broadly.

An airport could realize a best of both worlds approach in which the loan approval and repayment schedule are based on estimated savings, but M&V is then performed to verify that the project is functioning according to projections. Other airports might prefer to perform both upfront and retroactive M&V on larger projects and use project specifications and engineering estimates for smaller ones. See Appendix D for more details on M&V.

OPTIMIZE AND IMPROVE

5.3 Step 10: Optimize and Improve

5.3.1 Continuous Improvement

While some of the benefits of a GRF are stability and longevity, it must still adapt to changing conditions. Even after launching, the fund's design and management should be dynamic and adaptable. The most successful funds periodically reassess their performance and optimize accordingly. Some funds undertake a formal strategic review of their charter and governance every few years. It is important not only to address aspects of the fund that are performing poorly but also to reassess more foundational aspects of the fund, such as which stakeholders are involved, how cost savings are measured and revolved, the fund's mission and project criteria, and how the fund interacts with broader airport initiatives and goals.

One crucial area for monitoring and optimization is project performance. Key questions to consider include the following:

- Which types of projects are performing especially well both within the specific airport and among similar airports? Consider using these as a model for new projects.
- Are the original project criteria still effective for guiding the fund managers' decisions? They may benefit from adjustments as opportunities are exhausted or new ones emerge.
- If the fund is performing well, could it be expanded with more capital infusions?

Leverage the data on project performance collected in Step 9 to answer these questions and adjust the airport's fund strategy and the associated documentation. Adjustments may include expanding or narrowing project criteria (e.g., relaxing short payback requirements as the most cost-effective projects are exhausted), pulling in new airport stakeholders or staff to help identify or track projects, and adjusting the fund's accounting procedures.

5.3.2 GRF Internal Guidance Questions for Management

The following questions are provided for airports to evaluate their GRF internally approximately 6 to 12 months after implementation.

Process of Fund Management

- Have any issues arisen that were not addressed in the fund charter?
  - If so, consider updating the charter to identify these issues and outline solutions.
- Is there enough communication between the departments that manage the GRF?
  - Is project data being shared with all who need it?
- Is there enough staff (or staff time) dedicated to fund management?
  - Do roles need to be reevaluated or changed?

- Have all stakeholders in the GRF process been formally incorporated?
  - If all GRF stakeholders identified in the charter are not involved in fund management, make a plan to incorporate them.
- Are stakeholder needs being met?
  - Are these expectations reasonable in practice?

Project-Related Topics

- Have the GRF projects met the project criteria described in the fund charter?
  - Are the project criteria too narrow, preventing the consideration of important projects?
  - Are the airport's original project criteria still effective for guiding the fund managers' decisions? (They may benefit from adjustments as opportunities are exhausted or new ones emerge.)
  - Has the airport considered bundling projects with longer-term and shorter-term payback periods to achieve deeper efficiency upgrades while maintaining the desired ROI?
- Which types of projects are performing especially well (i.e., displaying resource reduction or financial returns beyond the thresholds in the GRF charter) both at the specific individual airport and among peer airports? Consider using these as a model for new projects.

Fund Finances

- Has the majority of GRF capital been utilized, or is significant funding consistently unused?
  - If the latter, what is the cause (e.g., not identifying enough projects)?
- Have the GRF's finances flowed smoothly and been tracked accurately?
  - If not, should the fund's accounting practices be changed?
- Has the airport adhered to the repayment schedule outlined in the fund charter?
  - If not, what is the cause?
  - Does the airport need to reduce the percentage of project savings repaid prior to the full repayment of the project cost?
- Are certain projects infeasible because of the total GRF size?
  - If so, are there available capital sources to expand the fund?
- If the fund is performing well, are there available capital sources to expand the fund?
- Has the fund been fully independent of annual budget decision-making to date?

Measurement and Verification

- Is project data (cost, payback period, etc.) being tracked effectively?
- Has the airport adhered to the M&V guidelines established in the fund charter?
  - Do these need to be updated? This may be useful if the capacity, budget, or expectations for M&V have changed.

Fund Achievements

- Have the projects undertaken through the GRF helped move the airport toward its sustainability goals?
- Has the GRF garnered the desired amount of public attention? If the fund is running well, it might be worthwhile to feature it in the airport's annual reports or website or develop other campaigns to inform a larger audience.

CHAPTER 6

Conclusions

GRFs are a promising option for airports seeking to improve their sustainability performance. The FAA has reviewed the GRF approach described in this report and finds that there are no regulations that would prevent an airport pursuing a GRF. While many of the traditional federal government grants cannot be used directly as seed funding, GRFs can be started without any new sources of capital using savings generated from already installed efficiency projects. Although airlines and other airport stakeholders may be unfamiliar with the GRF approach, airports can work with these stakeholders to explain how a GRF works and collaborate on fund implementation.

Airport-sponsored GRFs may only make sense for larger airports that spend at least $1 million annually on utilities. However, the VARF offers an alternative state model that could enable multiple smaller airports to participate without requiring the full implementation responsibilities. This could expand GRF adoption on a statewide basis to GA airports.

For airport early adopters, GRFs are a well-established method for generating new sustainability funding that has been tested and refined in higher education and municipalities. Individual champions must be willing to navigate in some level of uncertainty to advance GRFs at their airports and unlock this new financing mechanism.

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APPENDIX A

Frequently Asked Questions for Funding Airport GRFs

These FAQs were developed to address specific challenges regarding revolving funds at airports. They have been reviewed by the FAA. The FAA did not identify any regulatory restrictions for an airport to implement a GRF. Original source content has been adapted with permission from *Green Revolving Funds: An Introductory Guide to Implementation & Management*, published by the Sustainable Endowments Institute and the Association for the Advancement of Sustainability in Higher Education (Indvik et al. 2013).

What Is a GRF?

A GRF is a sustainability financing tool that invests money in projects to improve efficiency and potentially enable new sources of revenue, thereby reducing both operating expenses and GHG emissions. The cost savings that result from these efficiency projects are revolved back to the GRF, allowing it to return to its original size, or even grow. For the majority of fund models, after the initial project costs have been returned to the fund, additional savings accrue to the institution or a specific line of business's operating budget.

GRFs have three defining characteristics:

- The fund must finance measures to reduce resource use (e.g., energy, water, or paper) or to mitigate GHG emissions (e.g., renewable energy).
- The fund must revolve through a formalized mechanism, in which the savings generated by reducing operating costs are tracked and used to repay the fund to provide capital for future projects.
- The fund does not have initial internal capitalization.

Where Should an Airport Interested in a GRF Begin?

When contemplating whether a GRF makes sense for an airport, it is useful to start by reviewing current funding sources aimed at financing sustainability projects and obtaining a clear understanding of an airport's governance structure. Identifying the advantages and limitations associated with various sources of financing, airport ownership, and level of service will provide significant insight regarding specific barriers to be addressed during the GRF assessment.

Second, it is important to understand an airport's standard accounting practices used for resource efficiency projects. Capital will exit the GRF account to pay for the materials and labor associated with a project, and the resulting project savings must be returned from the budget, where they accrue, back into the GRF account to finance future projects. These transactions must be tracked according to standard airport accounting practices, which will ensure that

the circular flow of capital that defines the GRF is maintained. Consider which internal stakeholders would handle the accounting and financial flows for the GRF including tracking the utilities' budget where project savings accrue. If this involves stakeholders in different departments, do existing channels of communication and collaboration already exist or must these be developed?

Next, consider which external stakeholders (airport lines of business, groups, airlines, concessionaires etc.) need to be engaged in exploring and developing a GRF. Involving all relevant stakeholders early in the exploration process can increase the likelihood that obstacles will be uncovered, and support will be provided when the assessment turns into a GRF proposal.

What Are the Benefits of Having a GRF at an Airport?

Once capitalized, having a GRF ensures that sustainability projects will always possess a source of funding, which will ultimately save the airport money through reduced operating costs. If an institution already has dedicated money for sustainability efforts, using that money to create a GRF would capture the cost savings from the projects it finances and create a continuous cycle for funding (instead of a one-time funding allocation for individual projects). By tracking and reclaiming the project savings, GRFs continue to be available as a method of funding for efficiency projects and sustainability work.

GRFs provide the following benefits:

- Achieve institutional environmental goals and advance reduction in GHG emissions and resource consumption.
- Ensure initial investments in resource efficiency projects have an exponential impact by continually being reinvested.
- Boost ROI by mobilizing new capital to accelerate efficiency outcomes.
- Increase tracking of energy and water use (and other sustainability data).
- Hedge against rising or volatile energy prices.
- Create new opportunities for collaboration and cost-savings ethic among offices of finance, operations, maintenance, engineering, planning and environmental lines of business.
- Foster a culture of sustainability and resource efficiency (Sustainable Endowments Institute 2017; Flynn et al. 2012; Indvik et al. 2013; Sustainable Endowments Institute 2018).

What Is the Difference Between a GRF and a Revolving Loan Fund?

A GRF is dedicated capital from which sustainability projects are financed. With the growing prevalence of revolving funds, especially at the state level, some parties may use different terminology to refer to functions that could exist within a GRF. In some cases, revolving loan funds are established to finance projects unrelated to sustainability goals, and therefore do not count as a GRF. The best way to determine whether a revolving fund is a GRF is to refer to the structure of the fund, rather than its title (see the description provided in the first question). In this report, both "revolving fund" and "revolving loan fund" are terms referring to a GRF.

The word "loan" is used in this report to refer to capital withdrawn from the GRF account to finance a sustainability project that must be repaid with that project's savings. A "debt-based loan" is a term that can be used to describe initial sources of funding for initiating a GRF; however, projects that are capitalized by a GRF are also specialized "loans" that are repaid internally to the revolving fund. It is suggested that airports make a clear distinction between the two types of loans by referring to GRF sourced project funding as "GRF debt."

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What Sort of ROI Will a Fund Have?

GRFs collect utility savings from efficiency projects and provide reliable ROIs. Repayment periods are often short. Established funds have reported ROIs ranging from 20% (Georgia Institute of Technology and University of North Carolina at Chapel Hill) to more than 57% (Boston University), with a median annual ROI of 28%.

What Is the Average Payback Period for GRF Loans?

At the time of the publication of this report, there were no known GRFs currently implemented at an airport. Using 2012 data from higher education institutions, the reported average project payback of a GRF was 4.4 years. After loans have been repaid, additional savings begin to accrue to select institutional departments or distinct budgets within the organization.

Most institutions stipulate that loans must be repaid within a certain amount of time. Among the institutions that identified maximum/minimum payback criteria, the minimum reported project payback was 1.6 years, and the maximum was 7.8 years.

What Kinds of Projects Can a GRF Finance?

Airports are motivated to finance any project that will increase efficiency and reduce resource use. The following list of suggested projects also includes references to ACRP reports that can be reviewed for additional guidance:

- Lighting upgrades
  - Correlate lighting in public areas of terminals to flight schedules (*ACRP Report 139: Optimizing Airport Building Operations and Maintenance Through Retrocommissioning: A Whole-Systems Approach*) (Sebesta, Inc., 2015).
  - Install parking lot LED luminaires and controls (*ACRP Report 139*).
  - Replacement of screw-type bulbs (*ACRP Synthesis 21: Airport Energy Efficiency and Cost Reduction*) (Lau et al. 2010).
  - Multi-level switching and daylight harvesting (*ACRP Synthesis 21*).
- Water-efficiency retrofits
  - Install water-conserving aerators in lavatories (*ACRP Report 139*).
  - Use low-volume, high-pressure sprayer nozzles on water hoses used for vehicle washing (*ACRP Report 139*).
- Building efficiency improvements, such as heating, ventilation, and air conditioning (HVAC) upgrades
  - Upgrade building automations systems (*ACRP Synthesis 21*).
  - Replace variable frequency drive (VFD) controls to chilled water pumps or fans through a building automation system (BAS) (*ACRP Synthesis 21*).
  - Implement global set points for room temperatures.
  - Install low-e window films (*ACRP Report 139*).
  - Insulate ductwork (*ACRP Report 139*).
  - Provide additional roof insulation (*ACRP Report 139*).
  - Recommission and optimize existing buildings (*ACRP Synthesis 21*).
- Alternative-fuel vehicles
  - Expand use of electric vehicles or bicycles for fleet (*ACRP Report 139*).
- Measurement and Verification
  - Establish an M&V program to monitor energy use and identify potential opportunities for improvement (*ACRP Report 139*).

  - Install continuous metering equipment for lighting systems and controls, boiler efficiencies, indoor water risers, and outdoor irrigation (*ACRP Report 139*).
- Any project that can demonstrate cost savings by investing in energy, resource, or sustainability concepts

What Are the Criteria for Approving GRF Projects?

Institutions typically establish criteria that must be met for projects proposed for GRF funding. Often there will be a maximum payback period (e.g., 8 years), minimum/maximum funding amounts, or a minimum ROI.

Who Will Oversee the GRF?

GRF governance covers the various tasks that must be undertaken when managing a GRF. These tasks are as follows:

- Which individual or group will propose sustainability projects?
- Which individual or group will select sustainability projects?
- Which individual or group will account for financial flows out of and into the GRF?
- Which group will implement projects?
- Which individual or group will track and report project savings?

There are different ways to develop the GRF governance structure to oversee these tasks. Some funds utilize a management committee comprising various stakeholders from different departments. Another option is to have staff and resources from a relevant office, such as terminal operations, be placed in charge of the GRF. Some revolving funds will instead designate a dedicated manager to handle these tasks.

Is There a Size Threshold for an Airport to Be Best Suited for a GRF?

Technically, there is no size requirement for airports deciding on a GRF. However, airports that currently operate at a loss, or those that are projected to lose their current profit margin may not be good candidates for the savings reclamation model GRF. In the United States, self-sufficient and profitable commercial airport operations tend to have greater than 1 million annual passengers enplanements. However, this may vary across airports given a range of factors that include debt commitments, infrastructure condition, and efficiency of operations.

Airlines and debt obligations will likely mandate that all revenue sources cover losses and not permit the diversion of revenue to alternative budgets. If the airport operator has to cover a budget shortfall, operational cost savings generated by a GRF could not be reinvested into the revolving fund without first meeting the airport's prior financial obligations. It is possible that an airport with a pre-existing GRF could suspend reinvestment for a single year of loss and then restart the retained cost savings after returning to profitability.

Should a Large (Multi-Million Dollar) Fund or a Smaller Fund Be Proposed?

There is often a tradeoff between risk and reward when allocating funding to a GRF. Large capital allocations from existing sources (e.g., a capital budget) enable the fund to finance large capital-intensive projects that will produce a high volume of savings. Large funds are also more

likely to become firmly established, because they have more flexibility to finance projects and pay fund management expenses; however, the scale of the commitment limits other options for an airport. Conversely, incremental funding strategies (e.g., annual allocations from the capital budget or savings from existing projects) put fewer resources in play in case the fund encounters obstacles; however, this may prevent the fund from becoming established and quickly achieving the highest cost savings.

Many institutions have started small funds to demonstrate effectiveness, then scaled up once the administrative structure is operational. As Rosa Kerr, Dartmouth College's Sustainability Director, noted, "I would rather start small and knock it out of the park than bite off more than we can chew initially." For example, the Harvard Green Loan Fund was capitalized with $1.5 million in 1993, and it was repaid to the GLF and enlarged to $3 million from the central administrative budget in 2001. As a result of its consistent success, the fund was doubled in 2004 and again in 2006 to arrive at its current size of $12 million. However, other institutions, such as Macalester College, have encountered problems with starting small, finding that less capital in a GRF leads to a proportionately higher administrative cost and burden on staff. Additionally, starting small may limit the range of potential projects because of capital constraints (Indvik et al. 2013).

When deciding how to size an airport GRF fund and how to expand it over time, factors to consider include (1) the volume of potential projects and their ability to absorb capital, (2) your airport's tolerance for change and financial innovation, (3) the capacity of your fund management team and facilities department to support project implementation, and (4) historical performance from implementing/undertaking past projects.

Does a GRF Affect an Airport's Capital Budget or Operating Budget?

A GRF affects both the capital budget and operating budget in each of the three stages of the implementation process: seed investment, first-round of energy conservation project(s), and retained savings made possible through GRF projects. Because of the unique criteria and process of these stages, they are covered separately.

Seed Investment

Airports may plan to dedicate a specific dollar amount to serve as seed funding as part of their annual capital budget planning or could choose to designate a portion of unspent capital funding at the end of the year for the same purpose. The size of the source funding investment may require that capital budget funds be necessary, if internal operational budget thresholds are exceeded. Airports may decide that the seed funding is a one-time capital budget action to initiate their GRF (for the GRF endowment model, see question: What Types of Funding Sources Can Be Used to Start an Airport GRF?).

Alternatively, an airport may decide to provide additional funding after the first year to make more funding available and accelerate its growth. If the seed funding level is below capital budget thresholds, airports could draw from operating budgets to start their GRF or initiate specific projects in which the savings capitalize a GRF (for the GRF reclamation model, see question: What Types of Funding Sources Can Be Used to Start an Airport GRF?).

Initial Project Implementation

If the first GRF project draws funding directly from the GRF (endowment model), it would eliminate the need to use either a capital or operating budget. Airports may be motivated to

generate funding from a GRF, because it offers a simplified and dedicated source for new projects that are prioritized by payback performance and sustainability impact. Depending on how the GRF is structured, it may be managed by the airport as a new independent funding vehicle or as part of the operating budget. Once the GRF is implemented and tracked projects generate savings, that revenue may be used to reduce the annual allocation for the operating budget. Depending on the magnitude of savings generated from the GRF, it is possible that this new source of funding could also reduce capital budget project allocations.

Reclaimed Savings

Over time the GRF enabled projects will likely generate funding that exceeds the original seed investment amount. Similar to the initial project, the full GRF will potentially provide an alternative source that could reduce demands on either operating or capital budgets. After a number of years, the overall GRF may reach an equilibrium as older project actions stop generating savings according to their predetermined lifespan, and new projects generate savings to fill that gap.

What Types of Funding Sources Can Be Used to Start an Airport GRF?

There are two approaches for capitalizing a GRF, and the approach chosen will determine the types of funding sources that can be used.

The first approach is a traditional **endowment model**, in which an amount of funding is dedicated for the express purpose of capitalizing a GRF. The benefit of this approach is that the fund is immediately able to finance new projects. The drawback is that a suitable source of funding must be identified, typically one that does not need to be repaid and is compatible with a GRF.

The second approach, known as a **savings reclamation model**, starts with a project (already identified and either being implemented or soon to be implemented) that will result in operational cost savings. The project owner then captures the resulting cost savings and uses those savings to capitalize the GRF. To the extent that such cost savings are related to expenses allocated to airline rates and charges, the airport would capture only its share of cost savings for the GRF. Or, depending on an airport/airline use and lease agreement and rate methodology, the airport could seek airline consent to capture 100% of cost savings for the GRF. The benefit of this model is that the funding used to implement the target project does not need to be earmarked for the GRF itself, because the resulting savings capitalize the GRF. For this approach to work, however, the GRF processes to capture and retain the savings must be in place and all stakeholders must agree to use the operational savings in this manner. The drawback of this approach is that the process to capitalize the fund is slower. The savings reclamation model can also be used with projects that generate new revenue, not just cost savings.

A savings reclamation model is often easier to implement, because it can indirectly leverage federal, state, and internal capital budget funds that might not be eligible for use as an endowment.

Does Creating a GRF Constitute Revenue Diversion?

No, there is no statutory prohibition on the use of airport revenue to support a GRF or GRF-funded project for airport purposes; however, the GRF must adhere to the statutory limitations for revenue use and, where applicable, grant assurances and other restrictions.

Are There Any Common Federal Funding Sources for Airports That Are Compatible with a GRF?

Yes, under a savings reclamation model the operational savings resulting from projects implemented with either AIP funding or PFC funding could be used to capitalize a GRF; however, at this time, neither funding source is compatible with an endowment-model-funded GRF. See questions: Can AIP Funding Be Used to Fund a GRF? and Can Passenger Facility Charges Be Used to Fund a GRF?

Is Directly Endowing a GRF an Allowable Use under AIP or PFC Rules?

No, if the AIP statute does not provide the authority to fund an action or an item, that action or item cannot be funded under AIP. It is possible that special approval could be granted or a new sub-program like the Voluntary Airport Low Emissions Program (VALE) or the Airport Zero Emissions Vehicle (ZEV) and Infrastructure Pilot Program could be created that would make directly funding a GRF an allowable use of funds, but no such program exists at this time. Directly endowing a GRF is not a currently allowable use of PFC funds. Using PFC funds to directly endow a GRF would require special FAA approval.

Can AIP Funding Be Used to Fund a GRF?

Yes, indirectly. Under a savings reclamation model the operational savings (or additional airport revenue) from projects implemented with AIP funding could be used to capitalize a GRF, subject to general airport revenue use requirements and grant assurances. For the most part, AIP funding is not used to fund revenue generating projects, except for select project types (such as fuel farms) at non-primary airports. There is no such restriction on AIP-funded projects that result in operational savings.

At this time, AIP funding is not an allowable capital source for an endowment-model-funded GRF. See question: Is Directly Endowing a GRF an Allowable Use under AIP or PFC Rules?

Can Passenger Facility Charges Be Used to Fund a GRF?

Yes, indirectly. Under a savings reclamation model the operational savings—or additional airport revenue—from projects implemented with PFC funding can be used to capitalize a GRF, subject to general airport revenue use requirements and PFC assurances.

At this time, PFC funding is not an allowable source of capital for an endowment-model-funded GRF. See also: Is Directly Endowing a GRF An Allowable Use under AIP or PFC Rules?

Can Aviation Fuel Taxes Be Used to Fund a GRF?

Yes, subject to general airport revenue use requirements, aviation fuel taxes can be used in either a savings reclamation model or an endowment model. Federal law requires that aviation fuel taxes be used for airport-related purposes, if airports are participating in AIP. Most states already have aviation fuel taxes, a portion of which could be directed for GRF use, or a state

could increase taxes or levy a new tax for the express purpose of supporting a GRF. If an airport chooses to pursue this funding option, it will need to consult with its state government.

Can Revenue from Airline Fees Be Used to Fund a GRF?

Yes, subject to general airport revenue use requirements and provisions of any airport/airline use and lease agreement, airport revenue can be used for capital and operating costs related to airport systems and facilities owned or operated by airports. Creation and capitalization of a GRF are eligible investments for this type of revenue.

Can Revenue from Market-Rate Airport Operations Be Used to Fund a GRF?

Yes, subject to general airport revenue use requirements and provisions of any airport/airline use and lease agreement, airport revenue can be used for capital and operating costs related to airport systems and facilities owned or operated by airports, which includes the creation and capitalization of a GRF. Revenue from market-rate airport operations—parking, terminal concessions, car rental—is the most flexible revenue and can be used with both a savings reclamation and an endowment model.

Can Bonds Be Used to Fund a GRF?

Yes, under a savings reclamation model the operational savings or additional revenue from projects implemented with bond proceeds can be used to capitalize a GRF, as long as those savings or additional revenues are not obligated for the repayment of the bonds. General obligation bonds, general airport revenue bonds, and PFC-backed bonds would likely work with a savings reclamation model.

Bond proceeds, with the exception of PFC-backed bonds, could also be used to directly endow a GRF, subject to any applicable tax regulations. However, the GRF would need to invest in projects with rates of return and repayment terms sufficient to cover the bond payments.

Can an Airport with Existing Bond Debt Obligations Implement a GRF?

Depending on the structure of the existing bonds and the terms, it is possible. There are four basic types of bonds issued to fund airport capital improvements: (1) general obligation bonds supported by the overall tax base of the issuing entity (the airport sponsor); (2) general airport revenue bonds (GARBs) secured by the revenues of the airport and other revenues as may be defined in the bond indenture; (3) bonds backed either solely by PFC revenues or by PFC revenues and airport revenues generated by rentals, fees, and charges; and (4) special facility bonds backed solely by revenues from a facility constructed with proceeds of those bonds. Most bonds issued for large and medium hubs, and many small hubs, are GARBs. Bonds supported by specific revenue streams will likely be unaffected by use of either the savings reclamation or the endowment approach to GRF capitalization, as long as the creation of the GRF does not impact those revenue streams and the bond repayment. Airport staff should review the terms of the existing bond indentures. Choosing to capitalize a GRF through an additional bond issuance would impact the airport's debt capacity. In the majority of cases, existing debt would have to be prioritized for repayment over the GRF loan.

Are There Other Sources of Funding That Should Be Considered for Funding a GRF?

Yes, any source of funding that could potentially be used to pay for a capital project that generates savings or additional revenue should be considered. Some example sources include the following:

- State grants
- State infrastructure or green bank funds
- Utility incentives
- Utility savings resulting from rate optimizations, on-site solar or other renewable energy installations (depending on cost-recovery allocations under any airport/airline use and lease agreement)
- Foundation grants
- Savings from operational and behavioral energy efficiency—these could be from utility savings or other sources such as a reduction in labor requirements or decreased demand for services (e.g., converting actively landscaped areas to xeriscaping)

Can a GRF Be Implemented in Any Airport Building?

Yes, however, airport initiated GRFs will be most easily implemented in building assets owned by the airport. For building assets owned by other stakeholders, see question: Can an Airport Implement a GRF in Building Assets Not Owned by the Airport? In addition, considering how the airlines regard fairness of costs, operational cost savings or revenue generated from a GRF project(s) in one cost center (such as terminal) may need to be allocated within the same cost center to avoid any potential perceptions of unfair cost subsidization (Faulhaber et al. 2010). Therefore, it may be beneficial to set up a GRF account for each cost center at the airport.

Can an Airport Implement a GRF in Building Assets Not Owned by the Airport?

In general, the implementation of a GRF or specific GRF projects is the responsibility of the owner of the building asset in which the projects are being installed. However, an airport can structure a GRF to lend to third parties, such as an air carrier or other entity that owns a terminal or hangar. This would require buy-in from the building asset owner and established protocols for repaying the GRF.

What Factors Determine a GRF's Payback Mechanics?

Establishing a GRF requires a clear outline of the fund's payback mechanics (i.e., the size and timing of repayments). Though a GRF requires that all project costs financed through it be fully repaid, the amount and timing of repayments can vary. If an airport prefers to be conservative when forecasting project savings, a percentage less than 100% of the total can be returned each repayment period. This allows for greater caution about anticipated savings; yet, it lengthens the duration over which the project cost will be repaid. Airports will also have to determine how often savings will be repaid: monthly, quarterly, yearly, or by some other interval.

Table 2 is an example of a $100,000 GRF financing a $100,000 project in 2017. In Scenario 1, the fund is repaid with 100% of the project savings each fiscal year until the project cost is fully covered; in Scenario 2, the fund is repaid with 100% of the project savings and then additionally paid 50% of project savings for 2 years to grow the GRF.

Table 2. Example financing scenarios.

YEAR	AMOUNT LOANED BY GRF	ANNUAL PROJECT SAVINGS	SCENARIO 1: AMOUNT REPAID TO GRF (ASSUMING 100% ANNUAL REPAYMENT)	SCENARIO 1 GRF ACCOUNT BALANCE	SCENARIO 2: AMOUNT REPAID TO GRF (ASSUMING 100% ANNUAL REPAYMENT AND 50% OF SAVINGS FOR TWO YEARS)	SCENARIO 2 GRF ACCOUNT BALANCE
2017	$100,000	$30,000	--	$0	--	$0
2018			$30,000	$30,000	$30,000	$30,000
2019			$30,000	$60,000	$30,000	$60,000
2020			$30,000	$90,000	$30,000	$90,000
2021			$10,000	$100,000	$25,000	$115,000
2022					$15,000	$130,000

If the fund is designed to maintain its size over time, then repayment ends as soon as a project cost is repaid. However, if the fund is meant to grow over time, then an airport will also have to determine how the excess savings returning to the fund will be calculated. The calculations can be based on a percentage of total savings that will be repaid over a certain number of years (or the rest of the project's lifespan), a percentage of the overall project cost (i.e., committing to pay back 120% of a project's expenses), or as an interest rate on the outstanding project loan. Before planning for GRF growth via returned savings beyond the project cost, you must ensure that there are not stipulations or demands from stakeholders about these extra savings. Determining whether the fund should maintain its size or grow over time may be a matter of whether the GRF will connect with other airport initiatives or broader institutional goals, such as a sustainability master plan.

How Are Savings from a GRF Measured?

There are several methodologies to measure, verify, and capture the savings from GRF projects. For example, a straightforward and cost-effective approach is using front-end savings estimates for the duration of the project. These savings estimates would be provided in an energy audit or by a product vendor. This process will not capture any deviations in the event that a project performs better or worse than expected.

A more accurate approach is to retroactively calculate savings from an efficiency project based on actual performance. This requires airport operational staff to apply M&V protocols that account for factors such as annual weather changes and usage patterns.

Some institutions combine the best of both approaches, basing the loan approval and repayment schedule on estimated savings, and then performing an M&V to verify that the project is functioning according to projections.

Selecting the right methodology will depend on a number of factors unique to each airport, such as number of submeters, airport/airline use and lease agreements, concessionaire lease agreements, airport operational process, and utility payment structures.

Do Loans Made by the GRF Charge Interest?

While the majority of institutions do not charge interest on loans made by the GRF, for those that do, interest rates range from 1% (University of Texas at Dallas) to 5.5% (University of Minnesota, Twin Cities). The average interest rate that institutions applied to project loans was 3.3% (Sustainable Endowments Institute 2017).

Which Stakeholders Will Be Affected by the Implementation of a Funding Source for a GRF?

It depends on how the specifics of a GRF are implemented and the seed funding source. The following is a list of stakeholders that could be affected:

- Air carriers
- Passengers (education/promotion at a minimum)
- State and local government officials involved with utility payments at the airport
- Existing bondholders
- Airport administrators
- Finance
- Sustainability
- Planning/Engineering
- FBOs (depending on whether the airport owns the facility)
- Nonairline service providers (i.e., concessionaires)

When Should Airlines Be Involved If an Airport Implements a GRF?

As a critical stakeholder, airlines should be involved early in the GRF implementation process. The level of involvement will be dependent on the types of airport/airline lease agreements in place at the terminal where the GRF project(s) is being implemented. Operational expenses, such as utilities, can be the responsibility of the airport, airline, and concessionaires (or a combination of all three), depending on the specifics of the airport leases.

Therefore, airlines should be engaged early in the process to determine how GRF projects will affect the financial responsibility of the airlines, because GRF projects will measure and divert their corresponding utility savings back to the GRF. As a priority, airports should engage with airlines that enter into agreements that provide air carriers with greater control over airport operational revenues and capital decision-making. In some cases, GRF projects will be below an airport's capital budget threshold and may not need airline approval (see question: Does a GRF Affect an Airport's Capital Budget or Operating Budget?). As a general rule of thumb for GRF implementation, airlines should always be informed to maintain strong relationships.

How Do Residual Airline Lease Agreements Affect a GRF?

If the GRF seed capital comes from nonairline revenue, air carriers with residual lease agreements may support GRF implementation, because a reduction in operational expenses will increase the airport's ability to recognize a net surplus. During the GRF implementation stakeholder engagement process, airlines may request (or require) a portion of operational savings generated by a GRF project(s) be shared with the airlines.

How Do Compensatory Airline Lease Agreements Affect a GRF?

In a pure compensatory agreement, the airport is solely responsible for its financial risk and airport operations. Airports with pure compensatory agreements will require less engagement with the air carriers, because they have more discretion over capital and operational expenditures. However, air carriers will likely support the implementation of a GRF, because it will reduce the airport's total operational expenses, resulting in a reduced rental rate set within airport cost centers in which GRF projects have been implemented. The airlines would receive the benefit of a lower rental rate. It is important to note that while airports are not required by law to share nonairline revenues with the airline users (such as air carriers), the FAA does encourage the practice. Generally, airports with compensatory agreements share some portion of nonairline revenue, such as operational expense reductions, with airline users.

When Do Concessionaires Need to Be Involved?

The airport's level of administrative oversight will determine the extent concessionaires are involved in the application of GRF projects. Airports that lease and manage all concessions space will likely have the greatest ability to streamline the implementation of GRF projects. On the other hand, airports that contract out the management of concessions operations to an institutional operator would likely require a higher level of stakeholder engagement and may reduce the efficiency of GRF implementation. Ultimately, the concessionaire contract manager will determine the level of engagement the airport will need to have with concessionaires.

Factors that will influence the ease of concessionaire engagement include how the lease determines the concessionaires' portion of airport operational expenses and the level of submetering in each concessionaire space.

How Are GRF Procedures Typically Codified?

It's important to develop a written GRF charter to outline how the fund will operate and establish responsibility for its oversight. Sections include the following:

- Fund mission
- Source(s) of seed funding (and any accompanying regulations)
- Fund governance
- Project criteria
- Procedure for project selection
- Accounting and financial flows
- Project implementation
- Data tracking procedure for project selection and reporting
- Payback mechanics
- Process for reviewing and updating fund charter

Creating a tentative GRF charter, in which these topics are addressed, can act as a proposal for airports considering the GRF model. Approaching decision-makers with this outline will allow for more productive discussions and establish a foundation from which negotiations about fund parameters can proceed.

APPENDIX B

Energy Conservation Measures

Airport GRF Sample Menu of Operational Savings Opportunities

The following menu is a compilation of various efficiency measures that can be applied at airports of any size, location, or type. The efficiency measures listed were determined to be suitable for GRFs based on their implementation timeframe, implementation costs, payback period in years, and magnitude of savings. Although this menu is categorically comprehensive, the list of efficiency measures that may be suitable for GRF is not exhaustive. For additional insight relating to efficiency measures that may be suitable for GRFs, please refer to the References and Other Resources section of this report.

GRF Suitability Criteria

Implementation Timeframe

When available, an efficiency measure implementation timeframe is provided. Timeframe measures are based on a qualitative measure of time identified in Appendix G of *ACRP Report 139*. "Immediate opportunities happen on the order of days/weeks. Midterm opportunities take up to 2 years to implement. Long-term opportunities exceed 2 years to implement" (Sebesta, Inc., 2015).

Implementation Costs

When directly available, efficiency measure implementation cost ranges are provided. When cost figures were not directly available, implementation costs were categorized as "Low," "Low-Medium," "Medium," "Medium-High," and "High."*

Payback Period (Years)

Payback period represents the time required to recover the efficiency measure implementation cost. In general, short payback periods are preferred when considering efficiency measure suitability for GRFs.

*Note: For both implementation costs and magnitude of savings criteria, the categories "Low," "Low-Medium," "Medium," "Medium-High," and "High" were created based on the 1–5 weighting system included in Appendix G of *ACRP Report 139* (Sebesta, Inc., 2015).

Magnitude of Savings

When directly available, magnitude of savings are provided. When direct figures were not available, savings were categorized as "Low," "Low-Medium," "Medium," "Medium-High," and "High."

The following tables are provided as a resource of potential projects:

Table 3. Operations and maintenance measures.
Table 4. Lighting measures.
Table 5. Mechanical and HVAC measures.
Table 6. Water efficiency measures.
Table 7. Energy sources measures.
Table 8. Electrical loads measures.
Table 9. Building envelope measures.
Table 10. Automation and controls measures.

Table 3. Operations and maintenance measures.

OPERATIONS AND MAINTENANCE				
1	EFFICIENCY MEASURE			
	Control System Optimization and Recommissioning			
	OBJECTIVE			
	Normal deterioration of mechanical systems can be offset through HVAC or BAS system recommissioning and optimization. Systems can be evaluated and calibrated to meet their design specifications. This practice is most effective for spaces occupied by tenants that may lack regular maintenance practices. Space use or tenant changes are particularly useful periods for recommissioning application. Examples include chiller controller reprogramming, adjusting and repairing dampers and economizers, and verifying control sequencing.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Immediate	Low to Medium	0–2	Medium to High

(continued on next page)

Table 3. (Continued).

OPERATIONS AND MAINTENANCE				
2	EFFICIENCY MEASURE			
	Develop and Implement an Environmental Management System			
	OBJECTIVE			
	Developing an environmental management system (EMS) enables airports to better achieve environmental goals through a systematic approach, which can help to track progress, reduce the risk of noncompliance, improve health and safety practices, etc. According to the Sustainable Aviation Guidance Alliance (SAGA), capital costs to implement an EMS range from $5,000 to $100,000 and operations/maintenance costs range from $5,000 to $50,000 per year. Once the EMS is in place, these costs can be quickly recovered. For example, the Reno Tahoe Airport Authority (RTAA) has implemented numerous energy efficiency projects using the EMS approach including lighting and HVAC upgrades saving over $450,000 annually.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Capital Cost: Low ($5,000–100,000) O&M Cost: Low ($5,000–50,000)	0–2	Decreases energy consumption and generates renewable energy
3	EFFICIENCY MEASURE			
	Purchase and Operate Alternative Fuel Vehicles			
	OBJECTIVE			
	Alternative fuel vehicle options are becoming more and more widespread and cheaper each year. From biodiesel and ethanol to natural gas, hydrogen, and electricity, there are plenty of ways to reduce CO_2 emissions caused by daily vehicle operations. Airport management may be able to recognize significant savings by operating low to no CO_2 emitting vehicles.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Immediate	Medium ($100,000–500,000)	5–15	Decreases energy consumption

Table 3. (Continued).

OPERATIONS AND MAINTENANCE				
4	EFFICIENCY MEASURE			
	Install Centralized Preconditioned Air and Ground Power Systems for Gated Aircraft			
	OBJECTIVE			
	Aircraft on the ground require electrical power as well as preconditioned air depending on climate conditions. Instead of using onboard auxiliary power units (APU), aircraft ground energy systems (AGES) can be installed at each gate. Although the implementation of this measure will result in an increase in airport utility costs, as the end user, airlines are responsible for the additional energy consumed. Therefore, implementation costs and ongoing utility expenses can be recovered at a fair and reasonable rate as set by airline agreement negotiations. Ultimately, the benefits of this measure result in aircraft fuel savings, emissions reductions, and reduced noise originating from airports.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Low ($5,000–100,000)	2–5	Significant, multiple environmental and social benefits
5	EFFICIENCY MEASURE			
	Install US Environmental Protection Agency ENERGY STAR® Labeled Products			
	OBJECTIVE			
	The US Environmental Protection Agency and the US Department of Energy have developed the ENERGY STAR® program to help commercial, industrial, and residential sectors achieve greater energy efficiency. The program certifies equipment/products that meet certificated standards. Airports can install upgraded equipment such as HVAC systems, light bulbs, water heaters, and commercial food service appliances that meet program standards.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Low ($5,000–100,000)	0–2	Decreases energy consumption

(continued on next page)

Table 3. (Continued).

OPERATIONS AND MAINTENANCE				
6	EFFICIENCY MEASURE			
	Develop and Implement a Green Concessions Policy			
	OBJECTIVE			
	As major airport stakeholders, concessionaires play a significant role when it comes to airport energy consumption and waste management. Creating a green concessions policy can provide concessionaires with guidance and standards to reduce waste and improve recycling practices. Guidance could even include recommendations to use high-efficiency appliances that are ENERGY STAR® approved.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Low ($5,000–100,000)	0–2	Decreases energy consumption

Sources: Sebesta, Inc., 2015; Energy Systems Laboratory 2007; Lau et al. 2010; Sustainable Aviation Guidance Alliance 2015; Sustainable Aviation Guidance Alliance n.d.-a; U.S. Department of Energy n.d.-a; Sustainable Aviation Guidance Alliance 2014; Sustainable Aviation Guidance Alliance 2008; Sustainable Aviation Guidance Alliance 2013.

Table 4. Lighting measures.

LIGHTING				
1	EFFICIENCY MEASURE			
	Multilevel Switching/Daylight Harvesting			
	OBJECTIVE			
	Airport lighting efficiency in areas with significant exposure to daylight can be improved through the use of multilevel control sensors which balance artificial light with daylight. For example, daylight in airport parking garages can reach up to 150 feet. The use of multilevel sensors installed in airport parking garages may effectively regulate the energy needed to sufficiently illuminate perimeter parking bays.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Long-term	Low to Medium	0–5	Medium

Table 4. (Continued).

LIGHTING				
2	EFFICIENCY MEASURE			
	Monitor Lighting Systems Regularly to Maintain Proper Illumination			
	OBJECTIVE			
	Lighting should be constantly monitored to ensure that interior lighting falls within the building and exterior lighting remains on airport property. Additionally, automated light shielding controls can be implemented during late night/early morning hours to concentrate lighting where needed.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Low (<$5000)	0–5	Decreases energy consumption
3	EFFICIENCY MEASURE			
	Install LED (Light Emitting Diode) Lighting and Signals			
	OBJECTIVE			
	In addition to terminal and parking structure lighting upgrades, traditional aircraft navigation, runway, and taxiway lighting and signage can be retrofitted with high-efficiency light-emitting diodes (LEDs). LEDs can help reduce airport energy consumption, greenhouse gases (GHGs), and staffing requirements due to lower levels of needed maintenance. Additionally, when combined with sensor and control systems, LED efficiency can be further enhanced. According to the Department of Energy, "LED sources are inherently dimmable and instantaneously controllable."			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Medium ($100,000–500,000)	0–2	Decreases energy consumption

Sources: Sebesta, Inc., 2015; Lau et al. 2010; Gibbons et al. 2015; Sustainable Aviation Guidance Alliance n.d.-b; Sustainable Aviation Guidance Alliance n.d.-c; Sustainable Aviation Guidance Alliance n.d.-d; U.S. Department of Energy n.d.-b.

Table 5. Mechanical and HVAC measures.

	MECHANICAL AND HVAC			
1	EFFICIENCY MEASURE			
	Central Boiler Upgrades			
	OBJECTIVE			
	Replacement of outdated boilers can improve efficiency and reduce maintenance costs.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Immediate	Medium to High	0–10	High
2	EFFICIENCY MEASURE			
	Select Right Size and Install Energy Efficient Chillers			
	OBJECTIVE			
	There are various chiller systems, including air cooled, water cooled, and hydrofluorocarbon units. Typically, per ton, larger chillers are more expensive, so it may be cost-effective to replace a single large chiller with multiple smaller units. To help identify suitable equipment to meet individual airport needs – according to the Sustainable Aviation Guidance Alliance (SAGA) – the ASHRAE Standard 90.1, Energy Standard for Building Except Low-Rise Residential Buildings, "recommends the minimum energy efficiency requirements for chillers and an airport operator could use this standard to decide the minimum efficiency of the equipment selected." Additionally, the Department of Energy (DOE) Federal Energy Management Program (FEMP) provides chiller performance recommendations that can also help airport operators select appropriate equipment.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Low ($5,000–100,000)	2–5	Decreases energy consumption

Sources: Lau et al. 2010; Sustainable Aviation Guidance Alliance n.d.-e.

Table 6. Water efficiency measures.

WATER EFFICIENCY				
1	EFFICIENCY MEASURE			
	Install Water-Conserving Aerators			
	OBJECTIVE			
	Aerators reduce water flow. For example, bathroom sink faucets equipped with WaterSense labels can reduce water flow by 30% or more from the standard flow of 2.2 gallons per minute without sacrificing performance.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Immediate	Low to Medium	0–2	High
2	EFFICIENCY MEASURE			
	Water Metering and Submetering			
	OBJECTIVE			
	There are two types of meters, source, which measure the amount of total water entering a facility, and submeters, which measure how much water is being used for specific activities and equipment. The capability to accurately measure water use can help identify where upgrades are needed to improve water use efficiency. Additionally, submeters can be integrated into centralized building management systems which can electronically track water use and produce daily, weekly, monthly, and annual reports to easily identify building water use.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Long-term	Medium to High	0–2	Medium

(continued on next page)

Table 6. (Continued).

WATER EFFICIENCY				
3	EFFICIENCY MEASURE			
	Lavatory Water Conservation Measures			
	OBJECTIVE			
	Various lavatory water conservation methods exist; high efficiency fixtures can be applied to urinals and toilets, dry fixtures and composting toilet systems can reduce potable water demand, and alternate on-site water sources such as rainwater and stormwater can be captured for nonpotable uses.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Immediate-Midterm	Medium	0–2	20–40% Water use reduction
4	EFFICIENCY MEASURE			
	Greywater Treatment Via Anaerobic Filtration and UV Disinfection			
	OBJECTIVE			
	Various technologies are used for the treatment of greywater including physical, chemical, and biological processes. Although not extensively utilized, greywater reuse has become increasingly integrated into airport planning processes. Reuse examples such as irrigation of green areas, vehicle washing, toilet flushing, and other nonpotable water uses. Anaerobic filtration followed by UV disinfection offers a simple, relatively low-cost, and easily replicable treatment option.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Low to Medium	5	Medium to High

Sources: Sebesta, Inc., 2015; U.S. Environmental Protection Agency 2019a; U.S. Environmental Protection Agency 2019b; Lau et al. 2010; Chicago Department of Aviation n.d.; Krop et al. 2016; Sustainable Aviation Guidance Alliance n.d.-f; Couto et al. 2015.

Table 7. Energy sources measures.

ENERGY SOURCES				
1	EFFICIENCY MEASURE			
	Renewable: Solar Photovoltaic			
	OBJECTIVE			
	Renewable energy technologies utilized by airports have significant potential to reduce energy demand from local power grids, reduce energy costs, create a new source of revenue, and enhance airport resiliency. While installation costs have been historically high, capital costs in recent years have significantly trended lower over the past decade from $4.57 per watt in 2010 to $1.03 per watt in 2017 (cost assumptions include, but are not limited to a system size of 100 MW, a lifetime of 30 years, and a federal tax rate of 35%. For additional assumption details please refer to the NREL U.S. Solar Photovoltaic System Cost Benchmark: Q1 2017 report (Ran et al. 2017). In general, continued capital cost reductions over time will result in reduced payback periods; however, system payback is largely dependent on locational solar generation potential, utility costs, as well as potential incentives. Therefore, payback periods can vary.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Long-term	High (>$500,000)	1–10+	Decreases energy consumption and generates renewable energy
2	EFFICIENCY MEASURE			
	Install Geothermal Heating and Cooling Systems			
	OBJECTIVE			
	Using the natural heat storage ability of the earth, geothermal heating and cooling systems take advantage of the standard temperature below the surface. During cold winter months geothermal systems concentrate the earth's warmer temperature and transfer it to the air using a heat pump. In warmer summer months the reverse occurs; heat is extracted from the air through the heat pump and transferred back into the ground. According to the Sustainable Aviation Guidance Alliance (SAGA), in 2011 Portland International Jetport (PWM) received a Voluntary Airport Low Emission (VALE) grant to fund $2.5 million of a $3 million geothermal heating and cooling system installation. The system is estimated to save more than $160,000 annually.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	High (>$500,000)	5–7	Decreases energy consumption

Sources: Sebesta, Inc., 2015; Lau et al. 2010; Barrett et al. 2016; Barrett et al. 2015; Sustainable Aviation Guidance Alliance n.d.-g; Ran et al. 2017; Sustainable Aviation Guidance Alliance 2011.

Table 8. Electrical load measures.

ELECTRICAL LOADS				
1	EFFICIENCY MEASURE			
	Display/Equipment Shutdown			
	OBJECTIVE			
	Information displays, computer monitors, and office equipment such as printers can be manually or automatically shut down during off-peak hours. For example, building automation systems (BAS) can be used to turn off flight information displays (FIDS) and baggage displays.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Immediate	(<$5,000)	0–2	Medium to High/ Decreases energy consumption

Sources: Lau et al. 2010; Sebesta, Inc., 2015.

Table 9. Building envelope measures.

BUILDING ENVELOPE				
1	EFFICIENCY MEASURE			
	Reducing Infiltration and Loss			
	OBJECTIVE			
	Periodic inspections for air leaks around windows, walls, and roofs can be conducted. Infrared imaging can be used to identify areas of heat loss/gain, which can then be plugged.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Midterm	Medium	2–5	Medium to High

Table 9. (Continued).

BUILDING ENVELOPE				
2	EFFICIENCY MEASURE			
	Install High Reflectance/High Albedo Roofing Materials with a High Solar Reflectance Index (SRI)			
	OBJECTIVE			
	According to the Green Building Alliance, buildings that use "cool roofing" materials can recognize energy savings ranging from 7% to 15% of total cooling costs. Additional benefits can include reduced heat island index and pollutant emissions.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Medium ($100,000–500,000)	0–2	Decreases energy consumption/7–15% reduction in total cooling costs
3	EFFICIENCY MEASURE			
	Apply Thermochromic Coatings on Buildings			
	OBJECTIVE			
	Thermochromic coatings can be applied to building exterior walls and windows to help maintain comfortable building temperature. During winter months, coated surfaces become darker to absorb solar heat while in summer months these surfaces become lighter to reflect solar heat. Overall, this practice can help reduce building air conditioning and heating costs.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Low ($5,000–100,000)	5–15	Decreases energy consumption

(continued on next page)

78 Revolving Funds for Sustainability Projects at Airports

Table 9. (Continued).

BUILDING ENVELOPE				
4	EFFICIENCY MEASURE			
	Install Vegetated Green Roofs			
	OBJECTIVE			
	Benefits of green roofing include increased storm water retention, filtration, and evaporation, reduced heat island effect, reduced noise inside a building, improved building aesthetics, and improved roof lifespan from 15–20 years to 40–50 years. Careful consideration, however, should be given to the types of vegetation used in green roofing at airports to prevent the potential creation of foreign object debris (FOD) and to reduce the roof's attractiveness to wildlife.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Variable	Medium ($100,000–500,000)	2–5	Decreases energy consumption

Sources: Sebesta, Inc., 2015; Lau et al. 2010; Sustainable Aviation Guidance Alliance n.d.-h; Green Building Alliance 2016; Sustainable Aviation Guidance Alliance n.d.-i; Sustainable Aviation Guidance Alliance 2014.

Table 10. Automation and controls measures.

AUTOMATION AND CONTROLS				
1	EFFICIENCY MEASURE			
	Variable Speed Drives for Fans and Pumps			
	OBJECTIVE			
	Improve efficiency of building motor controls for conveyance, HVAC, and pumping equipment. Computer controls such as variable-speed drives (VFD) improve system efficiencies by automatically adjusting output based on real-time demand sensing and provide precise feedback to operations staff. Adjustments and fine-tuning of building systems can be made based on information provided to better accommodate airport schedules and occupants. Cost savings depend on equipment application and motor size.			
	IMPLEMENTATION TIMEFRAME	IMPLEMENTATION COSTS	PAYBACK PERIOD (YEARS)	MAGNITUDE OF SAVINGS ($, ENERGY, WATER, GHG, ETC.)
	Midterm	Low to Medium	2–5	Medium

Sources: Sebesta, Inc., 2015; Lau et al. 2010; Spevacek et al. 2014.

APPENDIX C

Case Examples

The GRF model is already well established across many different types of institutions, including higher education, K–12 schools, city and state governments, hospitals, and faith organizations. GRFs have been most commonly used and popularized on college and university campuses. The longest-running GRF was established in 1980 by Western Michigan University, where it continues to provide financing to energy- and resource-efficiency projects. Research conducted by the Sustainable Endowments Institute into GRFs in higher education identified 79 GRFs in operation in 2012 (Flynn et al. 2012). Ongoing research suggests that as of 2017, at least 140 GRFs are in operation in various sectors across the United States and Canada.

The following case examples explore how GRFs have been established at different institutions and illustrate the impact they can have in a short period of time. Additional case examples can be found at http://greenbillion.org/resources/#case-studies.

C.1 Non-Airport Case Examples

The City of Santa Barbara

The city of Santa Barbara's revolving fund (covered by the Utility Management Program Revolving Fund) was launched in 2016 and is aimed at financing EE/RE that would otherwise be constrained by the city's limited capital budget. An outside consultant was hired to research the revolving fund concept and facilitate stakeholder collaboration. Because of the city's reluctance to structure the capital disbursed from the fund as a loan, the fund is recapitalized only if annual energy expenditures are lower than the city's projected energy budget for the year, with the difference revolving to the fund. The fund is not currently open to enterprise departments, which manage their revenue and costs independently (such as the local airport). Santa Barbara hopes to open the fund to enterprise departments in the future. This case example is relevant as an example of a revolving fund hosted by a local municipality with an airport.

Harvard University

The Harvard Green Loan Fund demonstrates the long-term stability and significant financial impact enabled by GRFs. Originally capitalized with $1.5 million in 2001, average annual returns of 30% on sustainability projects convinced administrators to expand the fund several times. It now stands at $12 million, and as of 2011, had saved Harvard $4.8 million annually while reducing the campus's environmental footprint. This case example is adapted with permission from the Sustainable Endowments Institute's *Green Revolving Funds in Action* case study series (Foley 2011).

Denison University

The Green Hill Fund at Denison was established in 2011 after staff from the sustainability, facilities, and finance offices crafted a joint GRF proposal. The Denison administration's strong commitment enabled a rapid start for the fund, pointing to what is possible when institutional decision-makers believe in the GRF concept. In its first 2 years, the GRF financed 49 lighting upgrades and has since been expanded from $1 million to $3 million. This case example is adapted with permission from the Sustainable Endowments Institute's *Green Revolving Funds in Action* case study series (Blank 2014).

Lane Community College

Lane's Energy Carryover Fund has equipped Lane Community College to pursue its institutional sustainability goals. Through its first 8 years of operation, the fund had an average ROI of 23%. Lane has since restructured the fund to grow over time by maintaining project payback for 3 years beyond full repayment of the project cost. This case example is adapted with permission from the Sustainable Endowments Institute's *Green Revolving Funds in Action* case study series (Flynn and Silverstein 2014).

C.1.1 The City of Santa Barbara—Utility Management Program Revolving Fund

Summary

The city of Santa Barbara Energy Team (part of the city's Public Works Department) operates the Utility Management Program, a revolving fund that supports investment in EE/RE projects at city facilities. The revolving fund launched in July 2016 and has a unique structure that allows it to fit into existing departmental and budget allocation structures. This case example examines the revolving fund's creation, structure, and operational principles (A. Parenteau, personal communication, Dec. 4, 2017).

History

In 2014, the city of Santa Barbara Energy Team had a backlog of potential EE/RE projects that it was unable to fund because of limited city capital budgets. To overcome this hurdle, the Energy Team envisioned the creation of a revolving fund to be used for dedicated investments in city EE/RE projects. The city hired an outside consultant to conduct initial research and stakeholder engagement, and then to develop an appropriate concept for a new revolving fund (A. Parenteau, personal communication, Dec. 4, 2017).

Today, the fund covers only projects implemented by general fund departments, but the Energy Team hopes that it will be expanded to enterprise departments in the future. Enterprise departments generate their own revenue through fees for goods or services. Departments supported by general funds rely on tax receipts for funding. Municipalities typically keep enterprise funds and general funds separate to ensure that fee-based services are self-sustaining. For example, the airport in Santa Barbara is an enterprise department that generates its own revenue (A. Parenteau, personal communication, Dec. 4, 2017).

The revolving fund does not make loans at this time, given municipal concerns regarding a loan model structure. Instead, the fund provides capital funds for projects and captures utility budget savings over an open-ended timeframe. The term "loan" is not used.

Operations

Fund Governance Structure. The Energy Team manages the fund. It is structured as an EE/RE capital projects account held by the city of Santa Barbara.

Project Approval Process. The Energy Team manages project sourcing through multiple channels. First, there is a team of citywide energy ambassadors—City employees in various departments—tasked with informing energy decisions and coaching their departments on energy-saving behavioral changes. These energy ambassadors identify project needs and report back to the Energy Team. The Energy Team also proactively identifies energy-saving opportunities (such as LED street lighting) as part of the city's zero-net energy plans. Projects may also address immediate needs (e.g., an HVAC system fails and needs replacing). After identifying the potential projects, the Energy Team reviews and approves them in conjunction with the energy ambassadors (A. Parenteau, personal communications, Dec. 4, 2017, and Dec. 8, 2017).

Project Criteria. There are no formal criteria for project funding through the Utility Management Program. However, the revolving fund supports projects with a simple payback of 5 years or less.

Implementation Process, Savings Tracking/Revolving Process, and Accounting. Once a project is approved, funds are allocated from the revolving fund's EE/RE capital projects account.

For the purposes of the revolving fund, the Energy Team tracks savings at the citywide utility budget level against projected electricity and natural gas budgets. The city creates the utility budget projections based on an average of the previous 3 years of electricity and natural gas bills, plus an escalation factor of 3%. As EE/RE projects are implemented, actual utility expenses should decline, creating a surplus. At the end of each fiscal year, the city reviews actual utility expenses versus the projected budget and transfers any unused surplus to the revolving fund's capital projects account. There is no time limit within which an individual project must be fully repaid; instead, the city council reviews the amount to be revolved each year and adjusts that amount, if needed. This budget projection-based model theoretically leaves the revolving fund at risk, if utility expenses exceed projections; in such a case, the city could use the fund's capital balance to cover utility expenditures exceeding projections. The Energy Team tracks individual project performance and city utility expenditures monthly to ensure performance (A. Parenteau, personal communications, Dec. 4, 2017, and Dec. 8, 2017).

Project Spotlight

To build its initial capital balance, the fund spent its first year in operation evaluating city utility accounts to ensure that they were operating on the most beneficial rate structure. This process resulted in more than $60,000 in rate savings alone. Additionally, the city began upgrading its streetlights to LEDs. One hundred city-owned streetlights were converted from 150-watt fixtures to 50-watt fixtures, saving the city $5,000 per year (A. Parenteau, personal communications, Dec. 4, 2017, and Dec. 8, 2017).

Performance

The revolving fund reports performance annually to the city council. It completed its first full year of operation in July 2017. In the 2016–2017 year, the fund invested $25,000. Utility savings for 2017 totaled $87,459, mostly from utility rate optimizations. The total fund balance currently sits at $208,159, as a result of revolved savings and general fund allocations (A. Parenteau, personal communications, Dec. 4, 2017, and Dec. 8, 2017).

Conclusions

The city finance director, the city budget manager, and the city Energy Team were all crucial stakeholders to the successful creation of the fund.

The Energy Team prefers payments structured as surcharges—for example, as an energy efficiency line item on electricity bills. Structuring payments as surcharges prevents the fund

capital balance from being at risk for utility overages caused by factors outside of the Energy Team's control, such as behavior changes that lead to increased energy use.

C.1.2 Harvard University—Green Loan Fund

Summary

The GLF at Harvard University has been an active source of capital for Harvard's Schools and departments to implement high-performance campus design, operations, and maintenance projects. The GLF has accelerated the implementation of cost-effective EE/RE projects across campus. It has provided a dedicated source of capital for energy efficiency projects, allowing facilities to overcome the challenges of competing priorities for capital renewal projects within a constrained budgetary environment. The GLF has successfully financed projects that save the university electricity, natural gas, water, and waste disposal fees, along with other operating costs.

This case example examines the GLF's history, starting in 2002, when it was one of the first to be adopted by a higher education institution (although the fund existed as a pilot project starting in 1992). The GLF has been a successful self-replenishing tool for encouraging Harvard's facilities and operations teams to invest in projects that strengthen the university's research and teaching mission through cost savings, efficiencies, and resource conservation. Originally funded by the President's Office at $1.5 million as a pilot project, the GLF's size was thrice doubled, eventually becoming the $12 million fund that exists today.

Harvard's GLF has served as a model for other institutions and has been a foundational tool for helping the university meet its ambitious emissions reduction goals.

History

Harvard's GLF is reviewed on an ongoing basis to ensure it continues to meet the needs of the university's stakeholders and the evolving demands of the university's climate and energy commitments.

Harvard Green Loan Fund Overview

YEAR CREATED	2001
SIZE	$12,000,000
SOURCE	Offices of the President and Provost
AVERAGE PAYBACK PERIOD	3 Years
ADMINISTRATORS	Office for Sustainability
AVERAGE RETURN ON INVESTMENT	30%
TOTAL SAVINGS	>$4.8 Million Annual Savings

Changes that have been made as the GLF evolved over time include the following:

- The GLF has increased from the original $1.5 million to the current value of $12 million today, as demand for the fund grew.
- It has moved from requiring a simple payback analysis to requiring life-cycle cost (LCC) analysis (using Harvard's own LCC calculator).
- The GLF has increased the allowable repayment period from 5 years to 11 years.
- Funds can cover the full cost or the incremental cost of a conservation measure.
- The fund was interest-free until 2007, when a 3% administrative fee was added to defray administrative costs of the GLF and pay for initial consulting to ensure project teams followed Harvard's Green Building Standards. Based on feedback from university stakeholders, the fund has returned to providing interest-free capital because the administrative fee proved to be a significant barrier to using the fund.

Operations

Approving Project Proposals. The first step for an applicant wishing to utilize the GLF is to complete an LCC analysis of the

Table 11. Harvard University GLF performance.

ALL FIGURES ARE CUMULATIVE AND ANNUAL (EXCEPT ROI)	GLF FALL 2002	GLF SPRING 2003	GLF FALL 2003	GLF SPRING 2004	GLF FALL 2004	GLF FALL 2005	GLF SPRING 2006	GLF SPRING 2007	GLF DEC. 2010
CAPITAL ALLOCATED (LOANED, IN MILLIONS)	$1.0	$1.7	$1.8	$2.3	$3.25	$5.0	$6.5		Over $16.0
AVERAGE PROJECT ROI	N/A	30%		34%	40%	35%	33%	35%	30%
COST SAVINGS	$300K	$500K	$600K	$750K				$3.9MM	$48MM
NUMBER OF PROJECTS	N/A	18	18	23	38	38	92	130	185
POUNDS CO_2E SAVINGS (MILLIONS)	4	7	9	11.6		51	66.7	60.4	
WATER SAVINGS (MILLION GALLONS)	5	5.3	5.3	5.3		8.6	12.7	15.3	
SOLID WASTE SAVINGS (POUNDS)		200,000	200,000	200,000		200,000	200,000	200,000	

Note: This table highlights several measures of the GLF's performance over the years, including the average ROI of all loans issued so far for almost a decade, as well as some data on the performance of the Resource Conservation Incentive Program. Average annual ROI figures are based on highly detailed engineering estimates of the projected resource, maintenance, and cost savings resulting from the projects.

project using Harvard's LCC tool, which is populated with established university discount rates, energy escalation estimates, and other financial assumptions. After an applicant submits a proposal, the project then goes through an internal approvals process, which includes review by the Office for Sustainability (OFS), Green Building Services (GBS), Campus Services Finance, and the Vice-President of Campus Services. The project can be modified to address any concerns that are raised during the approvals process.

Once a loan is approved, the applicant moves forward with the project and sends paid invoices to the OFS, which issues the loan in the form of an internal fund transfer. The recipient of the loan begins repaying the loan at the start of the subsequent fiscal year, according to a payback schedule determined by the cost of the project and the annual cost savings. The fund will only reimburse projects that are successfully completed. For actual results, see Table 11.

Types of Loans and Loan Criteria. There are two primary categories of loan types: (1) GHG/utility reduction loans and (2) innovation loans. Projects are eligible projects if they include the following:

- Reduce GHG emissions
- Reduce energy use
- Reduce water use
- Reduce sewage or stormwater

- Reduce pollutants
- Improve operations
- Educate occupants
- Install renewable energy
- Purchase electric vehicles

These projects are subject to the following rules:

- Applicants must use Harvard's LCC for GHG emissions or utility reduction projects.
- Disbursed funds are repaid based on estimated annual savings.
- Applicants must pursue rebates or incentives.
- Projects must have a SIR of 1 or greater and be NPV+ (savings to university).
- Disbursed funds up to $1 million will be considered.
- Disbursed funds must be paid back within 11 years.
- Funds must be drawn within 1 year of the approval of the application.
- Applicants need to provide a revised application, if there is a change of scope requiring additional funds.
- Multiple conservation measures can be combined in one application.
- Funds can cover the full cost or the incremental cost of a conservation measure.
- Applicants are required to provide data verifying performance of implemented projects.
- Renewable energy and electric vehicle projects qualify for GLF loans regardless of the entire project's payback period.

Performance

These projects have produced a healthy annual ROI. Other highlights include the following:

- 225 projects funded since 2002
- Total of $26 million disbursed from the fund since 2002
- $7 million total annual savings to the university as of 2018
- Overall simple payback of 3.6 years (with many individual projects significantly longer than this)

Project Spotlight

Harvard Business School (HBS) used the Harvard GLF to install a 75kW cogeneration unit, along with infrastructure for the future installation of a second 75kW unit, in the basement of Shad Hall. The cogeneration units were installed to increase Shad Hall's overall energy efficiency and to substantially reduce energy expenses by simultaneously producing heat and electricity. The project had a payback of 4 years and resulted in an estimated reduction of approximately 769 metric tons of CO_2. The natural gas fired unit routes exhaust heat-to-heat exchangers that warm water for the entire domestic hot water heating load for showers. The unit feeds electricity into the building's main electric grid, supplementing building power provided from the grid and by photovoltaic panels on the roof.

Conclusions

Since its inception, the GLF has strengthened the university's research and teaching mission through cost savings, efficiencies, and resource conservation that help meet ambitious climate change and sustainability goals. The GLF fund has helped extend the reach of sustainability initiatives across the entire university by funding projects that deliver measurable and positive environmental change on campus.

OFS regularly reviews the GLF to ensure it fits within larger institutional sustainability commitments and goals. In February 2018, Harvard announced the next generation of its ambitious

climate goals, striving to become fossil-fuel-neutral by 2026 and fossil-fuel-free by 2050. Because many "low-hanging fruit" projects have been completed, the university is now at a turning point where projects with higher costs and longer paybacks must be encouraged. The future of the fund will have to evolve to address these developments in support of Harvard's research and teaching mission. These may involve expanding the evaluation criteria to focus on innovation and new technology, in addition to longer payback periods to accommodate costlier, higher impact projects.

C.1.3 Denison University—Green Hill Fund

Summary

Denison University's Green Hill Fund (a GRF) began in 2011 and was the product of collaboration among sustainability, facilities, and finance staff. The fund has leveraged Denison's commitment to reduce energy use and increase the number of opportunities for efficiency projects on campus to become a key driver for capital improvement and achieving carbon neutrality by 2030. The fund has drawn primarily from a project pipeline established by facilities staff through auditing from an outside company and is overseen by the Director of Sustainability and Campus Improvement.

Throughout its design and implementation, the Green Hill Fund has benefitted from the support and encouragement of decision-makers at all levels of Denison's administration. This support has enabled the fund to identify projects, build its operating and accounting structure, and invest hundreds of thousands of dollars in a relatively short amount of time. Initial projects focused on lighting, HVAC, and improving metering on campus, and staff are beginning to consider more comprehensive retrofits, as well as solar and geothermal for the future.

History

Denison University performed a university-wide energy audit in early 2011 with an outside company, Perfection Group, to assess the energy conservation measures (ECMs) that Denison could implement. Additionally, in early 2011, Denison's Campus Sustainability Coordinator was introduced to the GRF model through the Billion Dollar Green Challenge. Denison staff looked at energy performance contracts but preferred direct funding to secure the savings immediately.

At the end of the 2010–2011 fiscal year, Denison's Plant Adaptation and Renewal Funds (PAR Funds)—a portion of the annual operating budget spent on capital improvements—had approximately $1 million remaining. The university typically budgets about $7 million a year for PAR Funds, which enable Denison to maintain the physical plant and minimize deferred maintenance. The campus viewed this as an optimal opportunity to seed a revolving fund, because energy efficiency projects often overlap with the capital improvements that PAR Funds typically finance.

The Sustainability team sought to calculate the potential ROI from the energy audit's project opportunities to build its case for a GRF at Denison. The team then pitched the idea to the university president, who approved of the projected financial savings and allocated a portion of the PAR Funds and some designated and restricted gifts to capitalize Denison's fund with $1 million. In summer 2011, the Green Hill Fund began financing projects.

Operations

Identifying the First Round of Projects. During the first 2 years of the Green Hill Fund's operation, Denison decided to install projects, even if tracking and measurement systems were not yet in place. The campus was in an especially strong position to launch the fund, as it already

had a list of ECMs identified through its 2011 energy audit. With additional input from the facilities team, Denison assembled an initial list of 70 ready-to-implement projects.

Denison's practice of implementing projects ahead of its ability to track savings did not hinder the Green Hill Fund's operation. The fund's managers decided to base repayments to the GRF on estimated savings, until more precise measurement was in place. Denison was thus able to move forward on projects that created both cost savings and a visible impact on campus, while simultaneously developing the mechanisms for tracking energy savings.

Choosing the Right Projects. Potential projects for the Green Hill Fund are evaluated according to multiple criteria:

- Low implementation cost
- High opportunity for cost savings
- Estimated payback period
- Ease of implementation (time, complexity, disruption)
- Significant GHG emissions reduction
- Significant educational or research potential
- Significant social benefit beyond carbon
- Opportunities for partnership and collaboration within Denison and with the surrounding community
- High campus stakeholder buy-in and participation
- Ability for long-term success

Green Hill Fund Overview

YEAR CREATED	2011
SIZE	$3,000,000
SOURCE	Plant Adaptation and Renewal (PAR) Funds, a Portion of the Operating Budget
AVERAGE PAYBACK PERIOD	5.8 Years
ADMINISTRATORS	Campus Sustainability Coordinator, Director of Facilities, and Vice President of Finance and Management
AVERAGE RETURN ON INVESTMENT	17%

Managing the Green Hill Fund. The GRF team follows a guiding document that outlines the operating procedures of the fund. Once a project has been approved, the Accounting Office will direct funds from the GRF into a project-specific account. Depending on the project, the Facilities Services Department or an outside contractor will handle implementation and install equipment. Different members of the GRF team are responsible for tracking rebates for the Green Hill Fund, managing project implementation, and tracking project-related savings.

Simple Tracking and Accounting. The Green Hill Fund's measurement of energy- and resource-savings is based on both realized and estimated data. Obtaining realized data for some projects is simple because most campus buildings have electricity submeters installed. Savings calculations take into account previous university spending on electricity over the past 3 years and any changes that occurred after project installation. While no individual ECM (e.g., a lighting upgrade) is attached to a meter, Denison uses both engineering estimates and real-time whole-building data to calculate the amount of energy savings. In the future, Denison plans to normalize its estimated savings data for weather variations, providing an even more accurate view of a project's impact.

More Meters, Better Tracking. The Green Hill Fund also invests in projects that improve metering on campus to increase the level of possible M&V for the fund. One such campus-wide project will help many future HVAC projects observe energy use. By installing condensate flow meters around campus, a $36,102 project, the facilities team will be able to measure steam usage from all buildings. Each meter is attached to five or six buildings, and steam savings at the building level can be estimated based on this data. While implementing these meters does not result in direct financial savings for the university, the meters will improve

diagnostic capabilities to determine the efficiency of the system and steam savings from the Green Hill Fund and additional projects. The fund plans to recoup the project cost of these meters by bundling it with other projects that have faster paybacks and higher returns.

Project Repayment Process. The Green Hill Fund verifies energy savings at the end of each fiscal year and then makes a payment from the utilities budget to the GRF based on 100% of the calculated project savings. This savings payment will continue each year until 100% of the project cost has been recouped by the Green Hill Fund. During a project's repayment period, Denison maintains the utilities portion of the operating budget so that it can continue paying back cost savings to the Green Hill Fund. Once the project has been repaid and the annual cost of utilities has decreased, savings accrue to the operating budget. Based on these savings, increased utilities prices, and overall campus utility use, Denison can determine how much to decrease the operating budget.

Performance

Cumulative Project Data. With dozens of projects to finance during the first 2 years of the fund's operation, Denison invested $1,232,000 toward its GRF projects. During that period, it also received $133,562 in rebates, mainly from its utility company, American Electric Power, as well as a small amount from the EnerNOC DemandSMART program.

In the first two fiscal years of the Green Hill Fund, Denison saved $301,523. Denison calculated that this avoided approximately 19,590.9 million British thermal units (MMBTUs) or 5,741,500 kWh in energy use; these figures result from both electricity and natural gas savings.

With these savings, Denison will be able to reduce its annual carbon emissions by 6.9% (using the 2013 fiscal year as a baseline), supporting Denison's Presidents' Climate Commitment goal of carbon neutrality by 2030. The average annual ROI for projects funded in the first 2 years was 17.7%, with an average project payback period of 5.8 years.

Investing to Identify More Projects. In 2013, the Green Hill Fund took a chance by investing in two large projects with no direct payback: the condensate flow metering system and a study on the heating plant. The heating plant study was conducted to determine the economic feasibility of switching to natural gas or building a cogeneration facility as opposed to operating on coal as it does currently. Despite no direct cost savings, these projects were chosen because of their ability to help identify and track other Green Hill Fund projects.

Project Spotlight

Residence Hall Lighting Projects. In fall 2011, Denison used $375,025 from the Green Hill Fund on materials and labor to update lighting in all 33 campus residence halls. These lighting upgrades had been identified in the campus energy audit during summer 2011 and chosen by Denison for their combined estimated payback period of approximately 4 years. For the upgrades, estimated savings were calculated by assuming that the residence hall lighting would be on for at least 8 hours a day, which was chosen because lights are typically only used for a few hours during the daytime and used 4 to 6 hours at night.

These upgrades were installed in hallways and in students' rooms, as well as some exterior lighting. Perfection Group, an outside company, conducted the installations. The work involved switching out T-12 fluorescent bulbs with more efficient T-8 bulbs; in some cases, they installed even higher efficiency T-5 bulbs. The increased brightness from the upgrades meant that in a small number of fixtures, the lighting

Residence Hall Lighting Projects

INSTALLATION COMPLETED	December 2011 Average Project Cost: $11,373 per building
SIZE	$375,025
SIMPLE PAYBACK	5.4 Years
AVERAGE RETURN ON INVESTMENT	10.3%

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could be reduced from four bulbs to two or three. Exterior lighting was upgraded from halogen or metal halide to LED.

The lighting upgrades received $54,381 in rebates from the local utility, American Electric Power Company, which were applied back to the Green Hill Fund. The cost for materials and labor in each residence hall varied greatly, with project costs from $513 (in Shannon House, 1,800 sq. ft.) to $50,604 (in Shepardson Hall, 39,073 sq. ft.). The residence halls range in size from a single-family home to a building housing hundreds of students. The average project cost per building for these lighting upgrades was $11,373.13.

Bundling Payback Periods. The payback periods for upgrading each residence hall ranged from 1.3 years (Beta House) to 19.9 years (Huffman Hall). Denison estimates the average (mean) payback period for these projects to be 5.4 years, with a median of 4.3 years. The range in payback periods is due to several differences between the buildings including square footage, prior lighting efficiency, and cost of technology for each upgrade.

Denison financed lighting upgrades in residence halls at the same time to bundle shorter- and longer-term payback periods, which allowed implementation of projects with longer-than-normal payback periods.

Impact of Denison's Lighting Upgrades. Overall, these upgrades save the campus more than 877,889 kWh per year, an annual financial savings of approximately $66,672 per year. The average lifetime ROI for these projects was 103%. For this calculation, a conservative 10-year lifespan was assumed for the lights, although it is possible that many of the lights will last longer. The project has reduced Denison's GHG emissions by approximately 801.5 metric tons of carbon dioxide equivalent (CO_2e) emissions annually.

To inform the campus, an email notification went out about these lighting upgrades that detailed the financial and environmental returns the projects would provide. The community has noticed, too, with some Denison students reporting a better quality of light in their dorms.

Conclusions

Reducing Campus Energy Use. The impact of Denison's GRF projects can be easily seen when looking at campus energy use, normalized for weather, over the past few years (see Figure 14). Significantly, the campus MMBTU/square footage/degree day has gone down 13.5% between 2008 and 2013. The reductions that occurred during the 2011 academic year and the 2012 academic year correlate with the inception of the Green Hill Fund and the implementation of GRF and other efficiency projects across campus. The projects came at a crucial time for the university, as electricity prices rose 33% (from $0.06 to $0.08 per kWh) between 2011 and 2013. By making its buildings more energy efficient, Denison will counteract the rising utility bills that it would otherwise have incurred.

Growing the Fund. The community at Denison views the Green Hill Fund as an innovative tool for funding many efficiency projects on campus, to the extent that it would benefit from a larger budget. In fall 2013, Denison made the decision to grow the Green Hill Fund from $1 million to $3 million in the coming years, by adding $500,000 annually from PAR Funds.

"We were convinced that we were early enough in these efforts that it won't be challenging to find $3 million worth of good projects to do," commented the then-Vice President of Finance and Management. Denison's Campus Sustainability Coordinator also supported growing the fund as a way to finance more projects sooner stating, "This allows us to think a bit bigger each year."

As of 2018, the fund stands at $2.8 million with investments in 124 projects, resulting in an annual utility savings of $527,000. Since the fund's inception in 2011, Denison has realized a 28% reduction in energy usage across campus.

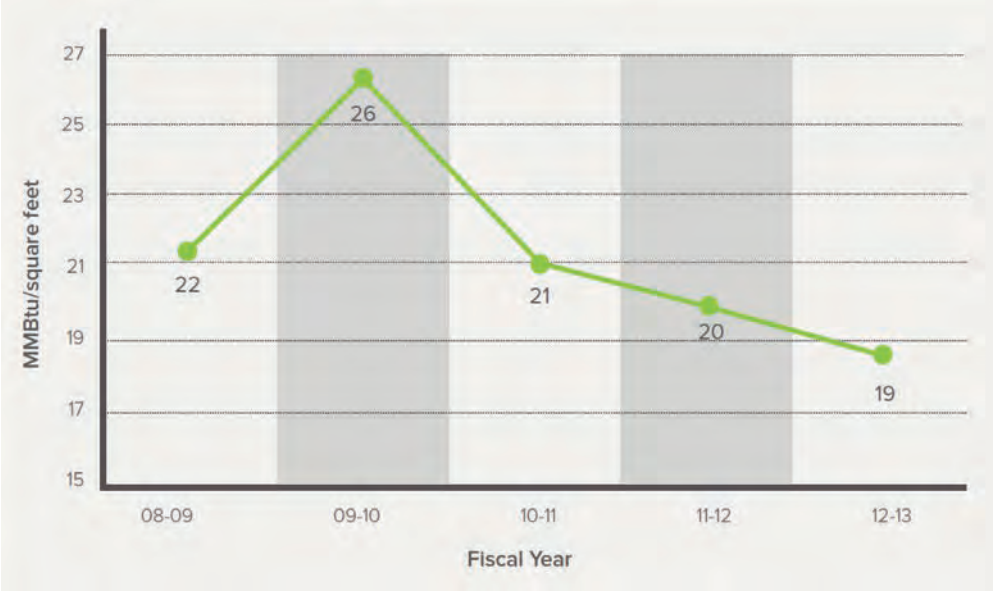

Figure 14. Total heating and electrical energy consumption at Denison University.

C.1.4 Lane Community College—Energy Carryover Fund

Summary

The Energy Carryover Fund, Lane Community College's (Lane's) GRF, was created in 2006 with an allocation of $166,000 from surplus funds in the college's utilities budget. The GRF has helped Lane meet its sustainability goals and formalize a process to identify energy efficiency projects. Since its creation, the Energy Carryover Fund has gone through operational and structural changes as Lane learned how to best utilize it. It was restructured in January 2016 to establish stronger repayment standards and was renamed the Living Green Revolving Fund; however, this case example examines the fund's original form.

The Energy Carryover Fund was administered by the Vice President of College Services, the Energy Analyst, and the Sustainability Coordinator. The fund had an average ROI of 23% and achieved a total of $113,000 in savings as of 2014. It also provided an opportunity to engage students in Lane's renewable energy program, enabling them to gain hands-on learning experience in selecting and implementing projects.

History

A Strategy to Reduce Energy Use. Before Lane adopted sustainability as a core value in 2007, its Vice President of Operations formally created a campus GRF. The fund, known as the Energy Carryover Fund, tracked the transfer of leftover money in the college's utilities budget and used it to finance EE/RE projects on campus. The Vice President recommended that the fund invest in strategies that would reduce energy use and enable Lane to seed a portfolio of renewable energy projects in which students could participate. The GRF concept was also chosen as a method to hedge against the school's rising energy costs.

The first step in implementing the Energy Carryover Fund was to record estimated cost and projected annual and total financial and energy savings (in MMBTUs) for 21 proposed projects. These projects included lighting efficiency upgrades, photovoltaic installations, and direct digital controls (DDC) commissioning.

Reallocating Savings from the Utilities Budget. Lane's initial GRF was structured differently than the typical GRF. While a traditional fund loans money for specific energy or resource

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projects and tracks the cost savings from each effort in a dedicated account, the Energy Carryover Fund was replenished by the leftover money between the operating expenditures at the end of each fiscal year and the projected annual energy savings (and related incentives) in dollars, which was then earmarked for energy efficiency projects. At the fund's inception, the college did not have comprehensive building submeters installed on the main campus, so to track energy savings, Lane developed a calculation for establishing annual energy savings based on an energy use benchmark from 2005 and the current year's energy prices. Because of the fund's atypical structure, it was less insulated from the college's budget pressures, which caused the fund balance to fluctuate.

Operations

Managing the Fund. Lane's GRF is managed within its Institute for Sustainable Practices (ISP) by the Energy Analyst and Sustainability Coordinator, who are responsible for the fund's day-to-day administration. Previously, the Energy Analyst had coordinated the fund within Lane's facilities department but, in 2013, the role transitioned to the ISP. This allowed the Energy Analyst to dedicate more time for data collection and analysis of campus projects.

Energy Carryover Fund Overview

YEAR CREATED	2005–2006
SIZE	$124,900
SOURCE	Unused Utility Budget from 2005. Incentives from Local Utility, and Capital Outlay Funds
AVERAGE PAYBACK PERIOD	3 Years
ADMINISTRATORS	Vice President of College Services, Energy Analyst, and Sustainability Coordinator
AVERAGE RETURN ON INVESTMENT	23%

Project Criteria and the Project Selection Process. Potential projects are chosen from a prioritized master list drafted by the Energy Analyst with help from energy management students, as part of a class requirement. Projects are prioritized and considered for approval based on the following set of criteria:

- Projected resource savings
- Funding availability
- Availability of incentives
- Expected life of the project
- Financial payback
- Creation of educational opportunities
- Timing within the academic calendar
- Availability of technical support to implement and oversee the project
- Ease of project maintenance
- Health and safety implications
- Support of Lane's core values
- Support of Lane's climate commitment

If Lane decides to hire an external contractor, that expense is included in the total project cost. The Energy Analyst is then responsible for tracking and monitoring the performance of the energy conservation measure or renewable energy project over time. These criteria allowed the college to plan multiple years of work and estimate energy use and the potential energy savings from Energy Carryover Fund projects.

Lane keeps its decision-making process informal intentionally. A small committee consisting of Lane's Facilities Director, Budget Officer, Sustainability Coordinator, Energy Analyst, Chief Financial Officer, and lead faculty in the energy management degree program makes decisions on a case-by-case basis. The committee relies on methodology outlined in a flowchart (see Figure 15) to determine which projects to fund. The flowchart takes into account opportunities for energy savings, projected project payback, and available incentives to ultimately decide whether or not a project should be funded.

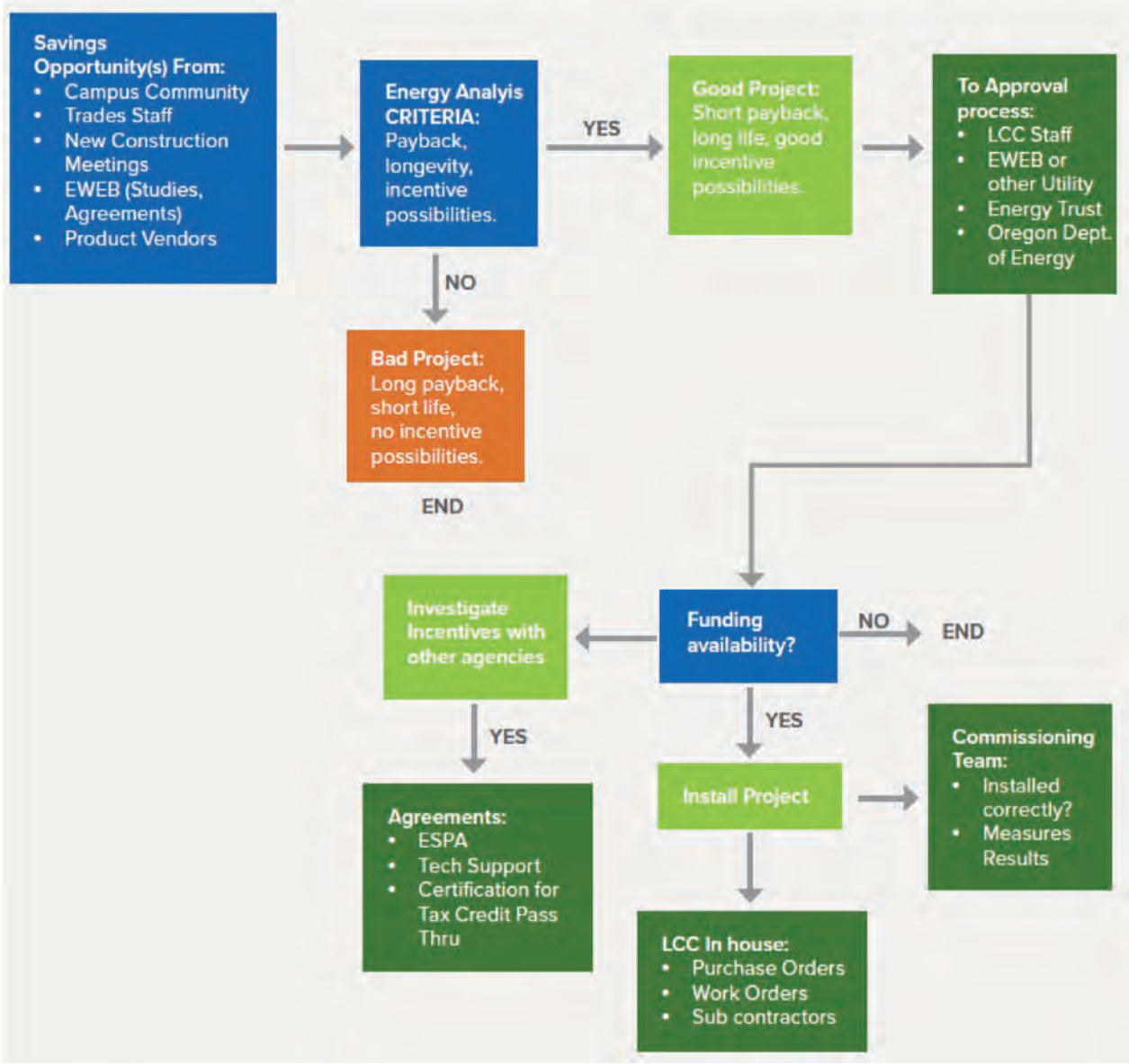

Figure 15. Lane Community College GRF decision flowchart (July 19, 2012).

Performance

Lane has made strides in reducing the campus' overall environmental impact through the implementation of its GRF. The college has realized consistent annual returns from low-hanging fruit projects, such as the installation of plug load controls, compact fluorescent lamps, low-wattage space heaters, and strategic heating and lighting use. These GRF projects have decreased Lane's overall building energy consumption but required little change in day-to-day activities for campus users.

Overall Impact. By 2014, the eight projects financed by the Energy Carryover Fund had reduced campus energy consumption by an estimated 8,211 MMBTUs. At that time, the largest project financed by the fund was the DDC Commissioning project. For more information, see the Project Spotlight section.

Project: Direct Digital Controls Commissioning	
INSTALLATION COMPLETED	2008
PROJECT COST	$32,088
SIMPLE PAYBACK	2.27 Years
AVERAGE RETURN ON INVESTMENT	37.3%
ESTIMATED ANNUAL SAVINGS	$14,115
ESTIMATED SAVINGS TO DATE	$85,748

Project Spotlight

In July 2008, Lane completed a recommissioning project in 17 campus buildings. The project was a continuation of a previous 2004 upgrade from the building's pneumatic mechanical controls to DDC. The upgrade created a hybrid system that kept pneumatic controls on the building's mechanical equipment (like dampers and actuators) and translated air signals into digital control. This change allowed for staff-centralized control of the entire building from a remote location via a computer network. Energy savings from the project were realized by strategically scheduling building mechanical equipment with the centralized DDC system according to the occupancy needs. The DDC project payback period was less than 3 years. Over the life of the project, Lane estimated savings of approximately $212,000 and an annual ROI of 37%.

Conclusions

Increased Identification of Projects through the GRF. By instituting a GRF, Lane's staff was given time to plan and compile a longer, more comprehensive project list and create a tracking system for the projects. The list has also allowed Lane to benefit from GRF-financed projects that advance the college's sustainability goals and capitalize on shovel-ready projects outside of the GRF, if additional financial resources become available.

Importance of Clear Fund Guidelines. Lane recommends establishing clear fund management guidelines and operating practices early to ensure that the GRF runs smoothly. The Energy Carryover Fund initially faced several barriers, because of the fund's dependence on the annual transfer of utility funds. However, Lane met an unanticipated situation when there were no leftover funds from the operating budget after the first year of operation. Year-to-year budget pressures, external factors, and internal funding competition also restricted the amount that was allocated to energy efficiency. In January 2016, Lane instituted operating guidelines to anticipate contingencies like this, established a separate GRF account, and now performs M&V for nearly all GRF projects. Thus, the Energy Carryover Fund was transformed into the Living Green Revolving Fund and has since been insulated from budget pressures even as the college has experienced budget shortfalls.

The GRF has been successful at promoting EE/RE projects, such as learning labs on campus, and encouraging student participation in renewable energy projects. The GRF investment also helped Lane infuse dollars and staff time into small but meaningful projects that otherwise may have gone unfunded. The fund has become an important tool to help achieve the college's climate commitment goals.

C.2 Airport-Related Case Examples

Hartsfield-Jackson Atlanta International Airport

Sustainability staff at Hartsfield-Jackson Atlanta International Airport (ATL) set up an account intended to be a GRF outside of the airport's operational and capital budget. However, the account, called the Sustainable Resource Fund (SRF), has yet to be capitalized. Staff are exploring various ways to capitalize the account. When ATL starts to make planned investments, SRF will likely become the first airport GRF.

Virginia Airports Revolving Fund

Research into funding at Virginia airports focused on the Virginia Airports Revolving Fund (VARF) administered by the Virginia Resources Authority (VRA). VARF is a state-managed revolving fund that finances airport projects but is not dedicated to sustainability projects, therefore, it is not a GRF. The fund is meant to cover projects at Virginia airports that are not eligible for state or federal grants. Between these funds and VARF, there is the potential for establishing airport-managed revolving funds through a savings reclamation model.

C.2.1 ATL—Sustainable Resource Fund

Summary

The Asset Management and Sustainability Division of ATL is working to establish the SRF. To date, it has successfully created an account for the SRF and is currently seeking sources of seed funding. The fund will pay for high-level resource efficiency upgrades, emissions reduction projects beyond the standard sustainability projects already undertaken each year at the airport, and purchasing of carbon offsets. Once the SRF is fully implemented, ATL will have the first self-managed airport GRF.

History

Rationale. The Asset Management and Sustainability Division has several reasons for pursuing an airport GRF. First, a GRF would provide stability in the form of a predictable funding source for sustainability projects and initiatives every year. Second, it would help isolate enhanced sustainability projects and initiatives, making it easier to quantify their impacts separately from other capital funding projects (i.e., the impacts will be evident in utility cost savings, which will in turn be used to replenish the fund). Finally, the Asset Management and Sustainability Division wants to undertake more significant sustainability projects to meet the goal of becoming one of the most resilient airports in the world. It envisions a fund that will go beyond funding operational improvements to funding capital improvements. The Director of Asset Management and Sustainability states, "We don't want to use SRF to fund activities that would be in the purview of enhanced sustainable design. If an airport wants to push the 'envelope'—the SRF could provide support and funding" (M. Cheyne and L. Milagro, personal communication, Feb. 18, 2018).

Campaign to Establish the Fund. ATL has a sustainable management plan and dedicates some funds to sustainability projects each year. The projects that the Asset Management and Sustainability Division proposes are considered in competition with other capital projects.

Outcome

The SRF account was established in the third quarter (Q3) of 2016, but it was not capitalized. While airlines at ATL agreed to designate an average of $1.8 million each year for sustainability projects (subject to review on an annual basis), thus far they have opted to do so through avenues other than the SRF. Today, the Asset Management and Sustainability Division is working to finance the new SRF through multiple funding mechanisms. So far, it has succeeded at capturing certain rebates from Georgia Power, which otherwise would have been allocated to the city's general fund. This is the only current funding source.

The Division is also exploring the ability to capture savings from projects funded by airlines in airport-owned areas. Unfortunately, these projects and the resulting savings have been hard to track, because the airlines undertake energy efficiency projects at concourses or terminals

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and pay for them through capital expenditures, without airport involvement. The Division is currently investigating ways to incorporate energy service provider contracts, in coordination with the airlines.

Another potential source of funding may be cost savings from projects financed through the city's revolving loan fund. Recently, ATL used capital from the city's revolving loan fund to finance an LED retrofit of the airport garages. After the loan was fully repaid, the savings were de-obligated from the utility budget and returned to the general fund. However, in the future, these savings could be deposited into the SRF to help capitalize it.

Other promising ideas include the "Good Traveler" program, a voluntary carbon offset program for individual travelers. As part of the offset sale, an additional fee could be applied to capitalize the SRF fund. Marketing fees on trash compactors and rebates from EV charging stations are additional options.

ATL is also in the process of establishing another revenue stream through an airport land management company. The company diverts waste to a processing plant for recycling, rather than the landfill. While more waste is being diverted from a landfill, the airlines are still paying their previous tipping fee. The Asset Management and Sustainability Division negotiated that the savings from diverting waste from the landfill—along with 15% of any revenue generated—will capitalize the SRF (M. Cheyne and L. Milagro, personal communication, Feb. 18, 2018).

Operations

Eventually, the airport, not the airlines or the state, will oversee the SRF. Once it is funded—likely through rebates and the other sources described—financial flows will be necessary to revolve project savings. As the Director of Asset Management and Sustainability states, "Nothing would preclude revolving savings. Everything we spend on sustainability should and could go back to a revolving fund." The Asset Management and Sustainability Division will be responsible for proposing projects. "Approval to expend SRF funds on capital projects will proceed through the typical Planning and Development capital project approval process or through the approved Specialized Construction Services methodology consistent with city of Atlanta procurement guidelines. The Deputy General Manager will approve use of SRF funds used on expense items" (Hartsfield-Jackson Atlanta International Airport 2017). Currently, the SRF receives no funding from energy efficiency project savings, because there is only enough capital to finance small projects with relatively little savings that would be too tedious to track. If the SRF grows to the point that it can fund major projects with highly visible savings, it will be more worthwhile to track the amount and reinvest it in the SRF.

Lessons Learned

Sustainability staff at airports should anticipate airline resistance to a GRF. If airports pursue revolving funds, they need to consider how to involve their partner airlines. As the Director of Asset Management and Sustainability observes, "Airlines may push back against earmarked funds." ATL has an excess fund, outside of the capital fund, that is independent of the airline agreement and contractual obligations. This structure can help to protect the integrity of the GRF and its capacity to provide reliable funding for sustainability projects, without being burdened by yearly requests for capital funding.

ATL is pioneering the GRF approach without any peer airports to share lessons learned and is addressing challenges as they emerge. Sustainability is still viewed with skepticism by many in the aviation industry. Cultivating a network of airports working to establish their own GRFs may increase the visibility of GRFs, enable knowledge sharing among active airports, spark a reevaluation of sustainability project outcomes by key industry players, and encourage other airports to

get involved. "If more airports were aware of the policy that we wrote, that would help (spread the concept)," states the Director of Asset Management and Sustainability (M. Cheyne and L. Milagro, personal communication, Feb. 18, 2018).

As the Director of Asset Management and Sustainability has witnessed firsthand, the initial size of the GRF matters. Establishing a large GRF is important, because it demonstrates that the time and resources invested to track and revolve savings are worthwhile; a small GRF may have trouble gaining momentum, because the projects are too small to merit careful tracking of cost savings.

C.2.2 Virginia Airports Revolving Fund

Summary

The VARF issues loans to help Virginia's public-use, publicly owned airports undertake projects that are not typically eligible for federal or state funding. VRA administers and oversees the VARF and is responsible for approving projects. The VARF was established in 2000 and capitalized with $25 million, allotted by the Virginia General Assembly. Since then, the fund has leveraged $90 million in airport project financing, surpassing expectations (M. Swain, personal communication, Dec. 7, 2017).

While the VARF is not an example of an airport-managed revolving fund or of a fund specifically dedicated to sustainability projects, it is one of very few operational revolving funds associated with airports. It demonstrates the positive potential impact of revolving loan funds and provides an alternative to individual airport-sponsored GRFs.

History

Many airport projects are eligible for federal and state funding through programs such as FAA's AIP, the PFC program, and Virginia Department of Aviation's state matching grants.

However, these programs are often oversubscribed and some airport project types—like most revenue-producing projects—are ineligible for Virginia state funding.

In 2000, VRA created VARF to (1) support airport projects that could not be funded through federal or state grants, with a specific focus on projects that generate revenue; and (2) expand the number of institutions that could draw on state revolving funds (M. Swain, personal communication, Dec. 7, 2017).

Operations

In its revolving fund capacity, VARF makes below-market rate loans to support the implementation of capital improvement plans at public-use, publicly owned airports in the Commonwealth. VRA administers and oversees VARF and is responsible for approving projects. A manager at Virginia's Department of Aviation Airport Services Division notes that, while there are no official criteria for determining whether a proposed project receives funding, VRA does look at each airport's approved 20-year Master Plan before reaching a decision. The plans tend to include the types of projects that should take place every 5 to 10 years, so VRA verifies that the proposed project fits into the airport's Master Plan. The general rule is that funding is "first come, first served." If the amount of funding requested exceeds the amount available, VRA can prioritize projects as needed but that has not yet been necessary (M. Swain, personal communication, Dec. 7, 2017).

Airports that cannot fund projects through federal and state grants often look to VRA for funding. VARF and other VRA loans often offer interest rates 0.5% below market rates, giving

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airports a cheaper option than a bank loan. Direct loans have ranged in size from $23,000 to $27 million, with 10- to 25-year terms. Monthly payments from outstanding loans recapitalize the fund on an ongoing basis (M. Swain and P. D'Alema, personal communication, Mar. 2, 2018).

To date, the most significant end use of VARF funding has been parking and hangar construction at GA airports. Apart from making revolving loans, the VARF also uses its capital to provide security for bond issuances, allowing it to leverage private capital to support larger projects (M. Swain, personal communication, Dec. 7, 2017).

Performance

With $25 million in initial seed funding, the VARF has funded $90 million in projects since 2000, surpassing VRA's expectations (M. Swain, personal communication, Dec. 7, 2017). To date, the VARF has not had any loan defaults and has lent at an average interest rate of 4.3%. The average loan size for the portfolio is $2.6 million, but projects have ranged in size from $23,000 to $27 million. Most projects are secured by a revenue pledge from the borrowing airport (or corresponding city or county). A revenue pledge is a provision that requires the borrower to use the net revenues to pay back the principal and interest on the loan before being allowed to use them for other purposes. Some of the projects have also been secured using special revenue pledges tied to the revenue generated from specific projects. At any given time, the fund has around $5 million in total dollars available to lend (M. Swain, personal communication, Dec. 7, 2017).

The VARF has supported a wide variety of project types including hangars, parking lots, fuel farms, lighting, and equipment (Virginia Resources Authority 2017). Specific examples include the following:

- Charlottesville-Albemarle Airport Authority has done a series of four projects funded through the VARF totaling just over $11 million including the design and construction of a rental car service facility, parking lot construction, and the construction of new parking in the terminal area.
- Hanover County/Hanover Regional Airport used VARF funding to construct new hangars including purchasing new electrical and gas equipment.
- Chesterfield County/Chesterfield County Airport used VARF funding to replace an existing fuel farm.
- Stafford Regional Airport Authority completed three projects using VARF funding totaling just over $3.4 million including the construction of a fuel tank farm and the construction of hangars, fencing, lighting, and other improvements.

Lessons Learned

The VARF provides an excellent example of how revolving funds can and do work in an airport context. It also provides a model for deploying a GRF solution at a state level instead of at an individual airport. A state-level fund can be particularly useful for small airports in which a limited number of smaller projects makes it hard to justify the cost of setting up and managing an airport-specific GRF. For these airports, a regional- or state-level fund solves that issue.

APPENDIX D

Measurement and Verification

Appendix D provides detailed guidance on how to measure and verify airport GRF performance. Part 1 describes M&V processes for tracking performance. Part 2 explores options for GRF management systems.

Part 1: Tracking Performance—M&V

D1.1 What Is M&V?

The concept of a GRF is based on investing in a project or process improvement that provides tangible, measurable benefits that will yield financial savings that can help pay back the investment. The term "project" is used in Appendix D; however, the GRF may be used to fund process improvements. To quantify the results of the project funded by the GRF, a method of tracking and documenting savings and results will be required. M&V is the industry term for this process. M&V processes grew out of the energy efficiency and energy savings performance contracting industry and, as such, industry documentation and best practices are typically associated with energy savings projects. However, the principles of M&V can be applied to a variety of project types.

The intent of the M&V process is to determine savings that are attributable to a specific set of actions taken. Determining savings requires two components:

- Baseline Performance: A baseline represents the performance level in the absence of the action taken.
- Post-Implementation Performance: The actual performance level that results from the action.

The savings attributable to the action is the difference between the two. It is a simple concept on the surface, but the question of savings attributable to specific actions and predicting performance in the absence of those actions has the potential to be complicated. The M&V process is not a one-size-fits-all proposition, so it needs to be developed in a way that best fits the needs and desired outcomes of the GRF. It also does not have to be a totally separate and discreet activity. Often the outcomes being measured are also being tracked for other purposes within airports. Identifying these potential overlaps can help streamline the process. The project-level results should also be tracked in a manner consistent with the GRF management tool that is selected.

This section of the study provides an overview of M&V, a decision-making framework to assist airports seeking to develop an M&V protocol, and potential resources. Most M&V resources are specifically focused on utility savings, such as energy and water, but the basic tenets of savings calculations can be applied to anything that can be measured and tracked. Because of the wide range of potential projects (and specific improvement measures within those projects), the strategy for setting up GRF M&V requirements is best focused on defining an overall M&V

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framework with an expected process and deliverables rather than specific approaches. This will allow M&V plans that are appropriate for each project to be developed.

D1.2 M&V Process

The M&V process usually includes four stages:

- **Plan development**. The M&V plan will typically be developed by the entity that is tasked with overseeing the M&V process.
- **Plan approval.** All parties with a stake in the outcome of the project should have an opportunity to review and approve the M&V plan.
- **Data collection.** The M&V plan will identify the source of the data needed for ongoing analysis and the entity that is responsible for collecting it. Depending on the project, this may include a pre-installation data collection phase that documents the baseline conditions that will be used in the savings calculations. It will include a post-installation data collection phase to confirm installation and performance.
- **Ongoing reporting.** The performance period will be defined in the M&V plan, which will dictate the duration and frequency of reporting. This should also be coordinated with the GRF management system selected for overall program tracking.

The GRF may choose to manage all of these stages internally or may outsource some or all of them to project teams or contracted service providers. In all cases, a GRF needs to develop a set of guiding principles for how M&V will be implemented on GRF-funded projects. These guiding principles are known as GRF M&V protocols.

D1.3 Developing GRF M&V Protocols

Projects funded through a GRF will fall under a variety of project types and will have a variety of variables to measure. Rather than attempting to account for all this variability upfront, a GRF should develop a set of **M&V protocols** that contain guidelines for how specific **M&V plans** are to be developed and implemented on funded projects. At a minimum, the GRF M&V protocol should cover the following:

- Risk allocation
- Measurement rigor
- Data gathering
- M&V responsibility
- M&V plan requirements

The M&V protocol will provide the framework for developing project-specific M&V plans. It should outline the expectations of what will be addressed in the M&V plan and the approval process for the M&V plan. The M&V plan development and approval process can be used to address the various needs of the projects being funded and allow the plan to be customized to the measure or project being funded. This will include how savings are to be tracked, who will track the data, and the M&V duration.

D1.3.1 Risk Allocation

A key factor that influences the M&V approach is the question of which entity accepts the performance risk from the project that is implemented under the GRF. Performance risk allocation determines which party takes responsibility, if the project does not generate the predicted savings. It is typically determined as part of the contract established for the project. Allocation of performance risk is a key part of M&V.

The GRF M&V protocols should have a process for conducting a performance risk assessment of projects being funded to identify and allocate the performance risk. To help all parties understand the risk expectations, the protocols should require the results of the risk assessment to be displayed in a matrix that defines each performance component and which party is accepting the risk.

D1.3.2 Measurement Rigor

A successful M&V plan will apply an appropriate level of rigor to monitoring savings that is in line with the value of the savings of the project. M&V will add some level of cost to the project, whether through equipment, such as metering, or labor, such as the ongoing analysis. It is not practical to develop and implement a robust M&V plan with an associated cost that outweighs the savings or consumes a substantial portion of it. The M&V approach for a project should identify the key variables that will impact savings and potential performance factors that need to be monitored, but ideally it will not create a disproportionate financial burden on the project. As an example, M&V costs for federal Energy Savings Performance Contract projects average 2% to 5% of the overall project cost (Webster et al. 2015). The rigor of the M&V approach will typically scale with the complexity of the project and the potential variability in the savings.

The GRF M&V protocols should have a requirement in place indicating that projects applying for funding conduct an M&V assessment to help identify an appropriate M&V approach that balances desired project outcomes and costs. Ultimately, this balance point is to be defined by the airport implementing the GRF.

D1.3.3 Data Gathering

Airports are large operations where monitoring and tracking performance for a variety of factors is a part of normal operations. Wherever possible, M&V data should be collected on an ongoing basis as part of an existing reporting process. Utilizing data that is already being collected has the obvious benefit of not adding a tracking burden on the operation; however, it may require that data be shared across operating groups that have not previously coordinated reporting activities.

When the data required for the M&V of a specific project is not currently collected by the airport, there may be an opportunity to integrate the data collection into an existing reporting process. The data may be of interest to airport stakeholders outside of the GRF project.

Under either scenario, the party responsible for collecting the data may be different from the party responsible for using that data for M&V calculations and reporting. It is important to define roles and responsibilities in the project-specific M&V plan.

The GRF M&V protocols should require that the data collected for M&V be compared with data already being collected at the airport, and that airport stakeholders potentially interested in new data streams should be identified. Anytime data is being used by more than one group or for more than one purpose, it increases the likelihood that tracking will occur, and performance gaps will be noted and addressed, thus increasing the likelihood of success of the project.

D1.3.4 M&V Responsibility

Understanding which party is accepting the performance risk can help determine which party is best suited to implement the M&V process. No matter who implements the M&V process, it should be performed in a transparent manner, so that all parties are able to review and understand the M&V outcomes.

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The GRF should have a requirement in place that projects applying for funding conduct an M&V assessment to help identify an appropriate party to implement the M&V approach. If an internal airport team approach is desired, that may be defined as the default arrangement; however, provisions should exist to allow exceptions to that rule. Utilizing a transparent M&V process can help mitigate potential conflicts of interest, because all parties will see the data and the results.

D1.3.5 M&V Plan Requirements

The GRF M&V protocols should include requirements for the content of the M&V plans to be developed for each project. Suggested content for a project-specific M&V plan includes the following:

1. **Project contact information.** Provide contact information for the parties involved.
2. **Project definition**. Provide an overview of the project, how savings will be generated by the project, and the estimated savings. An overall project schedule with key milestones should also be provided.
3. **Selected measurement approach and measurement boundary**. Discuss the approach selected and the rationale behind the decision.
4. **Baseline period**. The baseline period represents the facility or system performance without the project or measure being implemented. The project team should recommend a baseline period that captures a duration long enough to allow pre-installation performance to be documented. The appropriate baseline period will be tailored to the measure; it might range from short-duration spot measurement to a full year or more.
5. **Baseline data**. The baseline data is collected during the baseline period to establish the pre-installation operation condition. This will include specific variables to be measured and the duration of the measurements. This might include data from existing systems, such as sub-metering or building automation systems, or meters and dataloggers installed, specifically for the project. If data is shared between parties, the format of the data should also be defined.
6. **Performance period.** The performance period represents the expected post-installation period that will be monitored to measure and verify the savings generated by the project. This will likely be determined by the term established for participation in the GRF.
7. **Post-installation data**. Post-installation data represents the specific metering points that will be used to measure and verify system performance in the post-installation period. The frequency and duration of the data collection should be defined. If data is shared between parties, the format of the data should also be defined.
8. **Savings calculation methodology**. A description of the savings calculations to be used to compare baseline performance with post-installation performance should be included. This should also include any adjustments that will be required to account for impacts to the project performance that are not associated with the project. Given the growth many airports are experiencing, it is likely this will be a factor in many cases. Additionally, the methodology description should include any key input data, such as emissions factors for various fuels and utility costs that are used for financial calculations.
9. **Reporting frequency and formats.** The post-installation reporting frequency should align with the goals of the GRF and be in a format compatible with the GRF management system. Depending on the project structure, a comparison of the expected savings with the actual savings might be requested to help track performance.

D1.4 M&V Methodologies and References

The following references provide information and guidance for project-level M&V. An airport that is developing M&V protocols for a GRF should understand the various methodologies

that can be used for a project when setting those requirements. The following guidelines and references provide information on M&V processes including guidance on selecting a project- or measure-level M&V approach, defining baselines, identifying variables to be measured post-installation, and savings calculations.

D1.4.1 International Performance Measurement and Verification Protocol

One of the most widely recognized M&V documents is the International Performance Measurement and Verification Protocol (IPMVP) (Efficiency Valuation Organization n.d.). The Efficiency Valuation Organization (EVO), a non-profit corporation, assembles and oversees an IPMVP Committee of industry volunteers to develop and maintain the IPMVP. EVO publishes the documents. IPMVP provides guidance on developing and implementing M&V plans for energy and water savings projects. It provides a framework and guidance for developing specific M&V plans and discusses considerations to be taken into account when developing an M&V plan.

IPMVP defines various methodologies and approaches for ongoing savings M&V, from isolating the savings at the system or measure level to measuring savings at the whole-building level. Understanding this protocol may help an airport set the M&V guidelines for its GRF. The protocol is available for purchase on EVO's website.

IPMVP outlines four options (approaches) for measuring savings:

- **IPMVP Option A: Measure Isolation: Key Parameters.** This method is based on engineering calculations and partial measurement of key parameters to verify the savings resulting from specific measures. See Figure 16 (Webster et al. 2015).
- **IPMVP Option B: Measure Isolation: All Parameters.** This method is based on engineering calculations and ongoing site measurements to verify the savings resulting from the change in energy use of the affected system. See Figure 16 (Webster et al. 2015).
- **IPMVP Option C: Whole Facility/Meter Analysis.** This method uses whole-facility monthly or interval utility billing, or submetering energy use information, to evaluate savings. It compares the facility energy load profile in the baseline period with the energy load profile after implementation of the project. This method is mainly applicable to comprehensive projects

Figure 16. Retrofit isolation options.

on existing facilities that involve multiple measures with interactive effects between measures. Baselines are typically normalized to account for operating variables that may differ between the baseline and post-installation periods such as weather, number of passengers, or some other quantifiable variable. Any potential changes to the building load profile that are not associated with the project also need to be taken into account by making adjustments to the savings calculations. See Figure 17 (Webster et al. 2015).

- **IPMVP Option D: Simulation Model.** This method uses an energy simulation model of the facility that is calibrated to the facility meter or submeter data. Two scenarios of the model are created, one with the baseline conditions and one with post-installation conditions. Savings are calculated based on the energy consumption difference between the two. Option D is often used for new construction and comprehensive renovations in which there is no distinct baseline energy data available. Any potential changes to the building load profile that are not associated with the project also need to be taken into account by making adjustments within the simulation models. See Figure 17 (Webster et al. 2015).

D1.4.2 ASHRAE Guideline 14

Another resource for planning and implementing project level M&V is Guideline 14-2014 Measurement of Energy, Demand and Water Savings developed and published by ASHRAE (ASHRAE 2014). Guideline 14 presents three M&V approaches that are similar to three of the four approaches provided in IPMVP, one at the measure level and two at the whole-building level. Guideline 14 is focused on the savings calculation methodologies and provides more details for savings calculations using these options than the IPMVP does. It is a detailed technical document; however, understanding these guidelines may help an airport set the M&V guidelines for its GRF. The guideline is available for purchase on ASHRAE's website.

D1.4.3 Uniform Methods Project

IPMVP provides a framework for developing and implementing M&V plans, but it does not provide specific methods and calculations that should be applied to various energy savings measures. The U.S. Department of Energy (U.S. DOE) is currently developing a set of M&V protocols that will allow for consistent energy savings calculations for specific measures under the Uniform Methods Project (UMP) titled the Uniform Methods Project: Determining Energy

Figure 17. Whole-facility and calibrated simulation options.

Efficiency Program Savings (U.S. Department of Energy n.d.-c). UMP provides specific savings calculation methodologies for common energy efficiency measures that are based on IPMVP recommendations. UMP provides measure descriptions, savings calculation methodologies, M&V considerations including IPMVP options, data requirements for M&V, and alternatives for lower-cost M&V options. The measure-specific documents are detailed technical documents, but understanding what UMP is and how it is structured may help an airport set the M&V guidelines for its GRF. UMP documents are available for free download online.

D1.4.4 State and Regional Technical Reference Manuals

Many states have implemented utility energy efficiency programs. To help standardize savings calculations across program participants, many of those states have developed documents that provide guidance on energy savings calculations (or the state participates in a regional effort). These documents are commonly referred to as Technical Reference Manuals (TRMs). Although not specifically related to the process of M&V, they do provide standardized methods for estimating energy savings from common energy efficiency measures. As a result, they provide an excellent reference for potential energy efficiency measures and potential examples of savings calculation methodologies. TRMs are typically focused on measures that have relatively straightforward savings calculations and do not include custom measures.

If the measures being funded by the GRF are also receiving utility efficiency program incentives, the project team may want to use a TRM to estimate savings. One caveat for the use of TRM savings methodologies is that they are intended to estimate the collective savings from the measures within the territory or region covered by the TRM. Depending on the measure and its variables, the TRM savings calculations may include assumptions and streamlined savings factors that are based on research studies and past utility program data. Because they represent "typical" savings, the assumptions and savings factors may differ from the actual conditions at the site. These factors can often be easily updated with the appropriate variables at the airport, if needed, but an understanding of the measure savings calculations within the TRM is needed.

D1.5 Choosing the Right Approach

When choosing an M&V approach for a specific project, the airport should seek an appropriate balance of cost and rigor that meets the desired risk tolerance. Table 12 provides a summary of the various options for M&V approaches.

The decision tree in Figure 18 can also be used to help select an appropriate M&V option for a given project.

D1.5.1 Risk Allocation

Once an airport understands which aspects of the performance risk it is accepting, it can better understand the implication of various M&V approaches. Ultimately, the airport needs to agree to the level of performance risk it is accepting, understand the level of performance risk others are accepting, and understand how performance is being tracked.

On a given project, the risk allocation is likely to be separated into different parts, with portions assigned to various entities. For example, the variables that impact savings and who is responsible for them for a specific project may include the following:

- **Equipment efficiency**. New equipment is installed that requires less energy to perform the same function that is currently performed by existing equipment. An implementation contractor may accept the performance risk for the equipment efficiency it is installing.

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Table 12. Summary of M&V approaches.

METHOD	IPMVP OPTION REFERENCE	TYPICAL APPLICATION	LEVEL OF RIGOR	COST
STIPULATED SAVINGS: VERIFICATION OF MEASURE INSTALLATION AND ENGINEERING CALCULATIONS	N/A	Simple measures with low cost and savings; applications with low performance risk; Examples: lighting retrofit with programmed time schedule; plumbing fixture upgrades	Low	Low
MEASURE ISOLATION: MEASUREMENT OF KEY VARIABLE COMBINED WITH ENGINEERING CALCULATIONS	Option A: Retrofit Isolation – Key Parameter	Measures with a key variable that is relatively easy to measure and can be combined with established engineering calculations; Examples: lighting systems with measured run-time combined with data from published fixture wattages	Low to Moderate	Low to Moderate
MEASURE ISOLATION: DIRECT MEASUREMENT OF ENERGY USE AT MEASURE LEVEL	Option B: Retrofit Isolation – All Parameters	Measures with all parameters that can be measured Examples: direct energy measurement of equipment; direct water measurement of upgraded fixtures; short-term spot measurement of power for constant load equipment combined with run-hour monitoring	Moderate to High	Moderate to High
WHOLE BUILDING METER ANALYSIS	Option C: Whole Building	Meter data analysis using whole building meter or submeter that captures the performance of the installed measures Examples: Comprehensive controls upgrade; retrocommissioning; comprehensive water efficiency upgrade	Moderate to High	Low to Moderate
WHOLE BUILDING ENERGY MODEL	Option D: Whole Building Calibrated Simulation	Whole building energy model calibrated to post-installation building performance Examples: New building or additions; comprehensive renovations or whole building energy upgrades	High	Moderate to High

- **Operating schedule**. The new equipment will only save energy relative to the old equipment when it is operating. Airport operating hours are not under the control of the implementation contractor, so the airport may accept the performance risk associated with operating hours.
- **Equipment maintenance**. Ongoing maintenance of the new equipment may be required to ensure proper operation. Depending on the contract structure, either the implementation contractor or the airport may accept the performance risk associated with maintenance. It is likely that whichever entity is required to perform the maintenance will accept the performance risk.
- **External variables**. Performance risk for external variables, such as weather, are not under the control of the implementation contractor or the airport. These variables can typically be tracked, so their impact on the savings can be quantified. Performance risk associated with

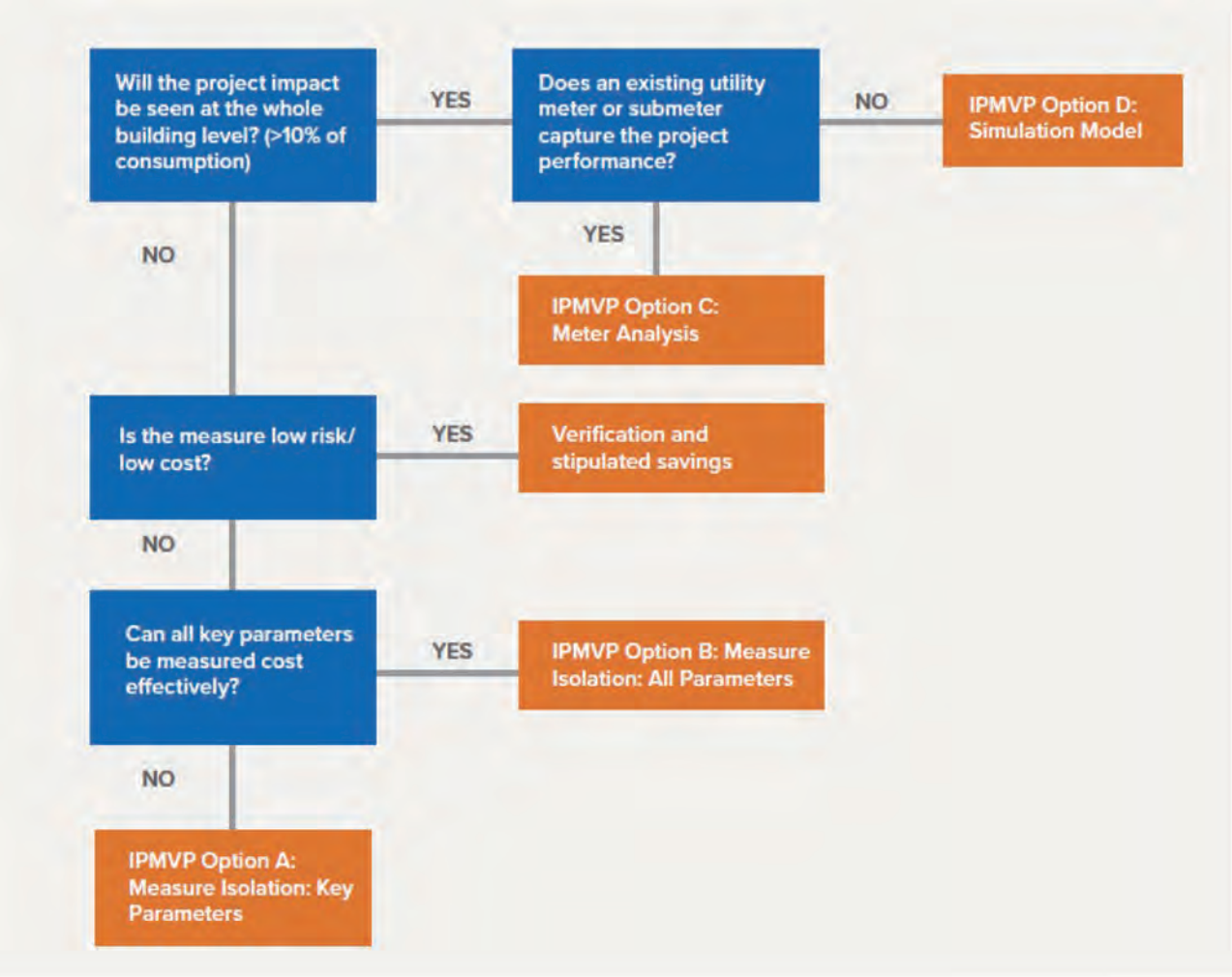

Figure 18. M&V decision tree.

external variables is typically assigned to the airport. The potential impacts of these variables should be understood by the airport.

Although not specifically related to M&V, a project structure that includes performance expectations and an allocation of the performance risk should also include a mechanism for dispute resolution in the project contract. Dispute resolution should be considered when developing the M&V plan, because the output from the M&V process will be an indicator of a performance issue.

D1.5.2 M&V Responsibilities

Each of these M&V stages can be assigned to any party for a given project. A single entity can be assigned responsibility for the whole process or each stage may be split amongst the team. Options for assignment of the M&V responsibilities include the following:

- **GRF manager**. The airport GRF team or an assigned internal representative can take responsibility for the M&V process. The benefit of using an internal resource is that the airport retains control over the process and internal resources may have a lower overall cost than external resources. The challenge is making sure the internal resource has experience with M&V, or has access to a resource with experience, and has the availability to support the

process. Depending on the project focus, various entities at the airport may contribute to different stages. For example, the energy management team may be responsible for M&V implementation for a project that is focused on generating energy savings, and the facilities management team may be responsible for a project to increase recycling rates. Generally, having the airport responsible for M&V will potentially result in the best outcome, but depending on the project contract structure, airport staff may have a real or perceived conflict of interest in the outcome of the M&V analysis.

- **Project implementation team**. A member of the team implementing the project can take responsibility for any aspect of the M&V process. The potential benefits include access to M&V specialists on the project implementation team, convenience for the airport staff, and a strong understanding from the implementer's perspective of the project and variables that may impact performance. The main drawback to this approach is that, depending on the project contract structure, the implementer may have a vested interest in the outcome of the M&V process, that is, the implementer may have a real or perceived conflict of interest in reporting the savings.
- **Third party**. An independent third party that has no financial stake in the outcome of the project can provide an unbiased approach to the M&V process. The third party can be hired by the airport or the implementer. A benefit of this approach is that a third party can be selected that specializes in M&V. The main drawback to this approach is typically the cost associated with engaging a third party. It is possible to supplement an internal team with a third-party resource to provide guidance and insight when needed. This may be particularly helpful when the GRF is initially being established. The third party could also be used to review and validate the M&V reporting performed by others.

D1.5.3 IPMVP Options

IPMVP provides these four options for determining conservation measure savings:

IPMVP Option A: Measure Isolation: Key Parameters. This method is based on engineering calculations and partial measurement of key parameters to verify the savings resulting from specific measures. For example, savings associated with a lighting efficiency upgrade might be determined using the following:

$$\textit{Quantity of fixtures}\,(\textit{verified by physical count})$$

$$\textit{Baseline watts per fixture}\,(\textit{based on published data})$$

$$\textit{Post-Installation watts per fixture}\,(\textit{based on published data})$$

$$\textit{Operating hours of fixtures}\,(\textit{key parameter measured using runtime data loggers})$$

$$\textit{Demand}\,(kW)\,\textit{Savings} = \textit{Quantity of fixtures} \times \frac{(\textit{baseline watts per fixture} - \textit{post-installation watts per fixture})}{1{,}000\,W/kW}$$

$$\textit{Energy}\,(kWh)\,\textit{Savings} = \textit{Demand}\,(kW\ \textit{Savings}) \times \textit{Operating Hours}$$

In this example, the savings are generated by three variables: the number of lighting fixtures, the change in lighting fixture wattage, and the operating hours of the lighting. The quantity of fixtures is verified once, the wattage savings is assumed to be constant based on published data, and the measured variable is the operating hours of the lighting fixtures. For the purposes of long-term M&V, the operating hours is the only measurement of a key parameter that is required.

IPMVP Option B: Measure Isolation: All Parameters. This method is based on engineering calculations and ongoing site measurements to verify the savings resulting from the change

in energy use of the affected system. For example, savings associated with the installation of a higher efficiency motor and variable frequency drive with controls to modify operation of a pump from constant volume to variable volume might be determined using the following:

Baseline kW and kWh (*based on measurements of motor during baseline*)

Post-installation kW and kWh (*based on measurements of motor after implementation*)

Demand (*kW*) *Savings* = *Baseline kW* − *Post-installation kW*

Energy (*kWh*) *Savings* = *Baseline kWh* − *Post-installation kWh*

In this example, the savings are generated by several variables, but they are all captured within the single measurement of motor kW and kWh.

IPMVP Option C: Whole Facility/Meter Analysis. This method uses whole-facility monthly or interval utility billing, or submetering energy use information, to evaluate savings. It compares the facility energy load profile in the baseline period with the energy load profile after implementation of the project. This method is mainly applicable to comprehensive projects on existing facilities that involve multiple measures with interactive effects between measures. Baselines are typically normalized to account for operating variables that may differ between the baseline and post-installation periods such as weather, number of passengers, or some other quantifiable variable. Any potential changes to the building load profile that are not associated with the project also need to be taken into account by making adjustments to the savings calculations. For example, savings from a major HVAC and controls upgrade might be determined using the following:

Baseline kW and kWh (*based on whole-facility meter or submeter data during baseline, normalized for operating variables*)

Post-installation kW and kWh (*based on whole-facility meter or submeter data after implementation*)

Demand (*kW*) *Savings* = (*Baseline kW* − *Post-installation kW*) ± *Adjustments*

Energy (*kWh*) *Savings* = (*Baseline kWh* − *Post-installation kWh*) ± *Adjustments*

In this example, the savings are generated by many variables, but they are all captured within the single measurement of facility level kW and kWh. Under this scenario, an example of an adjustment might be that a lighting upgrade project was also performed at this facility that was not funded through the GRF, so the savings from that measure would be removed from the savings calculation.

IPMVP Option D: Simulation Model. This method uses an energy simulation model of the facility that is calibrated to the facility meter or submeter data. Two scenarios of the model are created, one with the baseline conditions and one with post-installation conditions. Savings are calculated based on the energy consumption difference between the two. Option D is often used for new construction and comprehensive renovations in which there is no distinct baseline energy data available. The models are calibrated to hourly or monthly facility-level meter data, and submetering data within the facility can be used to verify model inputs and outputs, such as submeter data from lighting, plug loads, or gas. Normalization for operating variables that may differ between the baseline and post-installation periods, such as weather, number of passengers, or some other quantifiable variable are accommodated within the simulation models. Any potential changes to the building load profile that are not associated with the project also

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need to be taken into account by making adjustments within the simulation models. Using the same example from Option C, savings from a major HVAC and controls upgrade might be determined using the following:

Baseline kW and kWh (*based on whole-facility simulation model*)

Post-installation kW and kWh (*based on whole-facility simulation model*)

Demand (*kW*) *Savings* = (*Baseline kW* − *Post-installation kW*)

Energy (*kWh*) *Savings* = (*Baseline kWh* − *Post-installation kWh*)

In this example, adjustments for impacts to the load profiles that are not associated with the measures are already accounted for within the model.

Part 2: GRF Management Systems

One of the essential tasks of establishing a self-managed GRF is organizing and tracking the financial and project data associated with operating the fund. Part 2 explores the essential pieces of any GRF management system. It goes on to discuss the options available to an airport looking for this system: a build-it-yourself spreadsheet route or the use of an existing web platform designed for GRF management. The GRF Management System Options section weighs the trade-offs of each option.

D2.1 Requirements for GRF Management System

At a minimum, a GRF management system must be able to track the financial inflows and outflows of the fund and produce an accurate accounting of the fund balance and expected returns. A good GRF management system should also help the GRF management team track the pipeline of potential projects, track project-level performance data for funded projects, and provide useful reporting features and visualizations. Part 2 describes the critical aspects that make up a good GRF management system and provides example metrics/data points that should be tracked in each area.

D2.1.1 Financial Health Tracking

A GRF management system must be able to record the financial flows from the GRF to the project or entity implementing the project, and then from the resultant avoided costs (savings) back into the GRF. The tracking system must ensure that the full project cost is repaid to the GRF to maintain the fund over time and also account for modifications to the amount repaid at each interval (if it is less than 100% of savings accrued during that period or includes additional payments to grow the GRF). Any rebates received from utility programs or other sources should be recorded. Finally, transactions that affect the fund but do not pertain to specific projects must also be tallied. Together, these features allow the system to keep track of the total fund value and account balance available for investment in projects.

Metrics for Measuring Success: Fund Financial Health

- Total fund value
- Outstanding loans
- Available cash balance
- End of fiscal year projected balance
- Amount invested to date

- Amount saved to date
- Aggregate project expenditures
- Aggregate loan repayments
- Aggregate rebates received
- Aggregate non-project transactions

D2.1.2 Project-Level Tracking

The tracking of project-level data is another pillar of sound GRF management. The institution should differentiate between proposed projects, for which savings metrics can be calculated for evaluation purposes, and projects that are currently underway or have been completed. For each project status, the GRF management system should record project-specific details such as a title and description—providing context and information about new equipment—as well as quantitative metrics tallying the energy and resource savings accruing from the project. Cost savings and other financial metrics that highlight the project's success as an investment should also be calculated. The management system should also keep track of transactions associated with each project. For each project, the system should record an expenditure transaction (when the costs of materials and labor are paid for) and a project loan repayment (when project savings are returned to the GRF), noting any rebates received and factoring them into the financial calculations. To increase the accuracy of a project's quantitative data, it should be possible to update the unit cost and amount of the resource saved each year—especially if M&V techniques are used.

Metrics for Measuring Success: Project-Level Tracking

- Project status (proposed, in-progress, completed)
- Project name/title
- Project type (lighting, HVAC, etc.)
- Project description (types/amounts of equipment installed and other details)
- Resource types saved
- Resource units of measurement
- Unit cost
- Annual unit savings
- Project lifespan
- Project approval date
- Project installation start date
- Project completion date
- Lifetime ROI
- Annual ROI
- Simple payback period
- Adjusted payback period (if charging an interest rate or planning to repay savings beyond project cost)
- Net present value (NPV)
- Internal rate of return (IRR)
- Unit cost per metric ton of CO_2e abated
- Annual financial savings
- Annual energy savings
- Annual carbon emissions reduced
- Annual water savings
- Annual waste savings
- Lifetime financial savings
- Lifetime energy savings
- Lifetime carbon emissions reduced

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- Lifetime water savings
- Lifetime waste savings
- To date financial savings
- To date energy savings
- To date carbon emissions reduced
- To date water savings
- To date waste savings
- Project cost
- Project loan repayments
- Rebates received

D2.1.3 Reporting and Sharing

To get a big-picture view of the fund's track record, the GRF management system should also be able to calculate aggregate metrics for the full portfolio, such as total savings and other financial metrics. Other optional functions should also be considered, such as the ability to generate visual representations of project data—charts and graphs—that can be important for conveying the impact of the GRF to outside stakeholders. Being able to monitor particular data points over time or view data at the facility level may also be useful.

Finally, having a system for sharing project data with other institutions that are also aiming to improve their energy and resource efficiency can facilitate best practice sharing and allow for benchmarking against peers. The ease with which this data is shared is therefore an important consideration.

Metrics for Measuring Success: Aggregate Reporting

- Number of projects funded
- Average cost
- Average annual ROI
- Average payback period
- Average project lifespan
- Average annual financial savings
- Average annual energy savings
- Average annual carbon emissions reduced
- Average annual water savings
- Average annual waste savings
- Average unit cost/$MTCO_2e$ abated
- To date financial savings
- To date energy savings
- To date carbon emissions reduced
- To date water savings
- To date waste savings
- Savings by project type
- Savings by facility
- Savings by campus (group of buildings)
- Savings by custom project group
- Net cash flow over time

Ease of Use and Security. A good GRF management system should be accessible to stakeholders who may not have day-to-day familiarity with the workings of the fund. It is important for facilities staff or other fund managers to periodically collaborate with other offices, especially financial decision-makers, who need to be informed about the evaluation of proposed

projects or the outcomes of completed ones. Having an intuitive system becomes even more important when personnel change and new staff are assigned to manage the GRF. The GRF management system must be secure and backed up to ensure data integrity and preservation.

D2.2 GRF Management System Options

There are two common options for GRF tracking: (1) building your own system via data management/spreadsheet software like Excel or (2) utilizing an existing project-management tool. When setting up a GRF, an airport must identify a tracking system that meets the requirements outlined as well as other organizational priorities.

D2.2.1 Excel-Based Tracking

The first route that an airport can take is to design its own GRF management system from the ground up, explored here through the spreadsheet software Excel.

In designing the system, it may be useful to split up the features into different sheets:

- Sheet instructions
- Fund financials
- Project-level tracking
- Aggregate calculations
- Reports

Stakeholders outside the facilities office must be able to read and understand the spreadsheet. It may be necessary to have a group meeting, so that all fund overseers can be informed about how the system works, if there are areas to avoid, and what their responsibilities are in using it. The **sheet instructions** would include descriptions of each part of the overall spreadsheet, definitions for all terminology and metrics calculated (perhaps with written-out formulas), guidance for how the sheet must be maintained, and an explanation about who is responsible for each section. Care must be taken not to create multiple versions of the spreadsheet, if it is managed by multiple people. It should also be backed up regularly. See Figure 19 for an example of an airport Excel-based GRF spreadsheet.

The **fund financials** sheet will be used to keep track of the total fund value and fund balance over time. It must communicate with the project-level tracking sheet, so that projects selected for financing through the GRF have their actual project cost (expenditure) logged, reducing the fund balance. Whenever project savings are returned to the fund, this must be logged (increasing the fund balance), and the remaining project loan should be reduced accordingly. Rebates received by projects and returned to the fund must appear here, increasing the fund balance. Any fund transactions not associated with a project must be included, but they should be clearly separated from project-linked transactions.

The **project-level tracking** sheet is where all resource reduction data and project savings data are housed. The sheet should track the resource(s) or fuel(s) saved by each project, corresponding units of measurement, unit cost, number of units saved annually, and the project lifespan. This data allows you to generate both resource and financial savings across different time spans. To calculate carbon emissions savings, you will have to incorporate the carbon intensity of the resources or fuels being saved. The carbon intensity of numerous fuels can be taken from the U.S. government mandatory reporting rule factors (U.S. Electronic Code of Federal Regulations 2019). Carbon emissions factors for electricity at U.S.-based institutions are available via the Environmental Protection Agency's (EPA's) Emissions & Generation Resource Integrated Database (eGRID) (U.S. Environmental Protection Agency n.d.). Also, projects will have to be clearly delineated by status: proposed, in-progress, or completed.

	A	B	C	D	E	F	G	H	I	J
1	**Example Revolving Fund Spreadsheet Tool**	**Airport GRF Data Input Guide** Use this guide to input your past, current, and future project data. Complete as much relevant information as possible as this data will be added to your project portfolio.								
2		* means Required for all projects				** means Required for only Completed projects				
3										
4	**Project Name ***	**Building(s)**	**Building Type**	**Building Year**	**Lead**	**Project Status ***	**Description ***	**Project Type ***	**Project Subtype ***	**Proposed Cost ***
5	*Use this column to identify your project*	*Name of building(s) in which this project took place*	*Click in cell and select type from list*	*Year of construction*	*Project leader's name*	***Proposed:** not yet approved or started **In-Progress:** approved and currently underway **Completed:** project is complete*	*Use this space to describe the project, including any relevant make and model of equipment installed, scope of the project, etc.*	*Click in cell and select project type from list*	*Click in cell and select project subtype from list*	*What do (or did) you expect this project to cost initially?*
6	Control System Optimization and Re-commissioning	Terminal A	Airport	1985	Jane Smith	Completed	Normal deterioration of mechanical systems can be offset through HVAC or BAS system recommissioning and optimization. Systems can be evaluated and calibrated to meet their design specifications. This practice is most effective for spaces occupied by	Building Heating, Ventilation	Retrocommissioning	$25,000.00
7	Install Centralized Pre-conditioned Air and Ground Power Systems for Gated Aircraft	Terminal B	Airport	1997	James Harris	Completed	Aircraft on the ground require electrical power as well as pre-conditioned air depending on climate conditions. Instead of using onboard auxiliary power units (APU), aircraft ground energy systems (AGES) can be installed at each gate. The benefits result in	Electrical Systems	Power Quality Improvement	$20,000.00
8	Replace existing parking garage lighting with high efficiency LED (Light-emitting Diode) Lighting	Short-Term Garage	Parking/Garage	1989	Jane Smith	Completed	Changed 700 fixtures from T-12 to LED in garage. LEDs can help reduce airport energy consumption, greenhouse gases (GHGs), and staffing requirements due to lower levels of needed maintenance. Additionally, when combined with sensor and control	Lighting	Lighting upgrade/retrofit	$150,000.00
							Replacement of outdated boilers can improve efficiency and reduce maintenance costs.			

Figure 19. Example of GRF spreadsheet with basic functionality.

You will have to decide whether to evaluate proposed projects in the same spreadsheet as projects that have received GRF financing (and whether to keep them all in a single project-level tracking sheet), or whether to create a separate file.

To get a high-level picture of the GRF's track record, there should be an **aggregate calculations** sheet that incorporates the data from all project entries. Just like the project-level tracking sheet, you must separate the proposed projects from those that are in-progress or completed (so as to avoid lumping hypothetical data together with projected and realized data). This sheet can feature a mix of averages for all financed projects (in-progress and completed), such as average annual financial or energy savings, as well as total calculations (e.g., lifetime carbon savings). You can compare the data calculated in this sheet against the project evaluation criteria outlined in the GRF charter to see how well your project portfolio is adhering to the desired GRF impact.

Finally, there should be a **reports** section where charts and graphs can be generated from your savings data. You may decide to keep these charts alongside the projects or aggregate calculations from which they are derived or set up a separate sheet for them. The existing sheets will easily allow for project-level and whole portfolio graphs, but if additional detail is desired (e.g., viewing savings by facility or project type), then project data may have to be arranged into custom groups.

Please see the example figures (Figures 20, 21 and 22) derived from the only currently available software service (described in section D2.2.2), illustrating the qualitative and quantitative project-level data that should be included in any spreadsheet-based tracking system. Other essential pieces including the tracking of fund finances and calculation of aggregate metrics would also have to be added, if an airport chooses to develop its own spreadsheet approach.

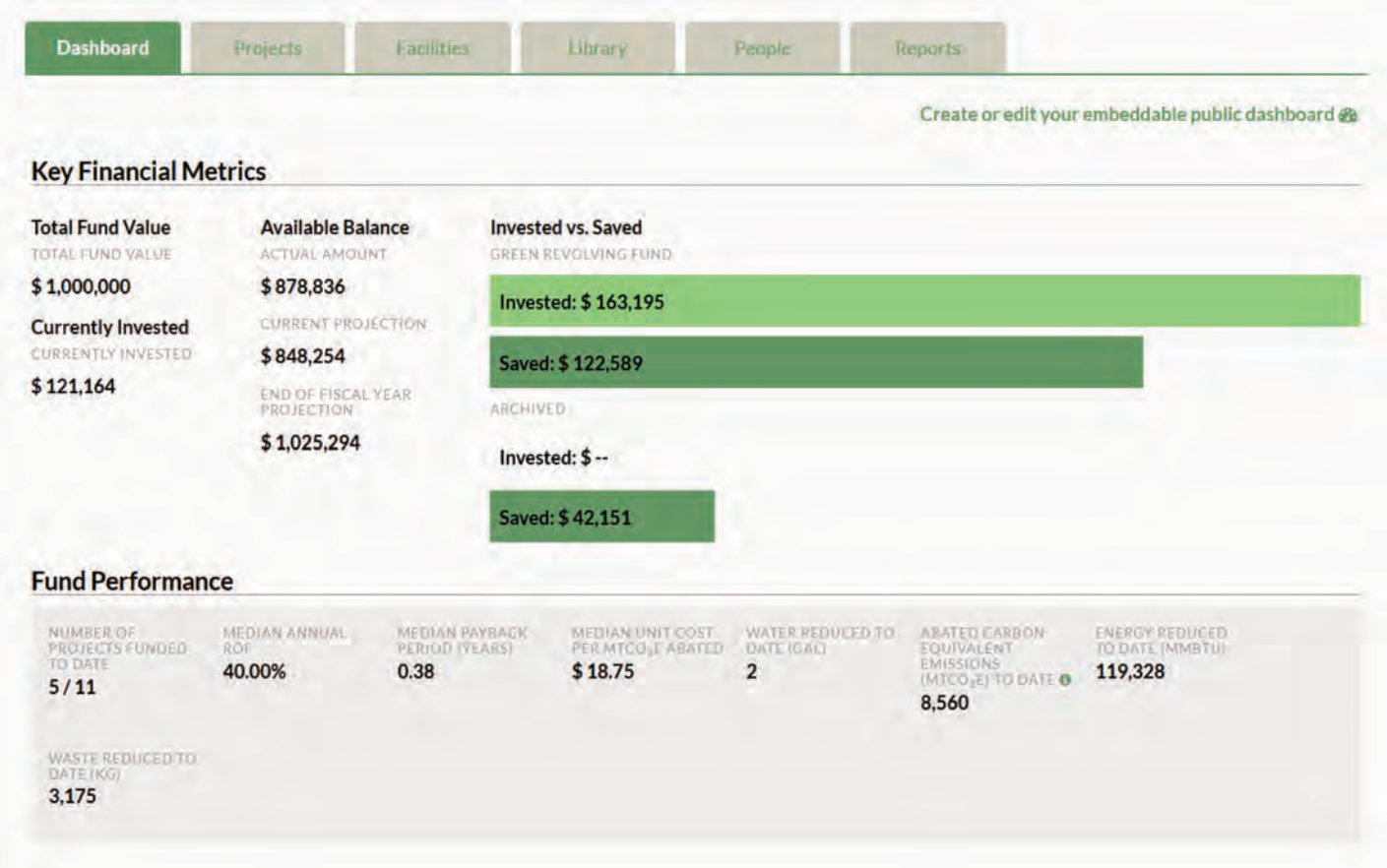

Figure 20. Key financial metrics functionality (featured with permission from SEI).

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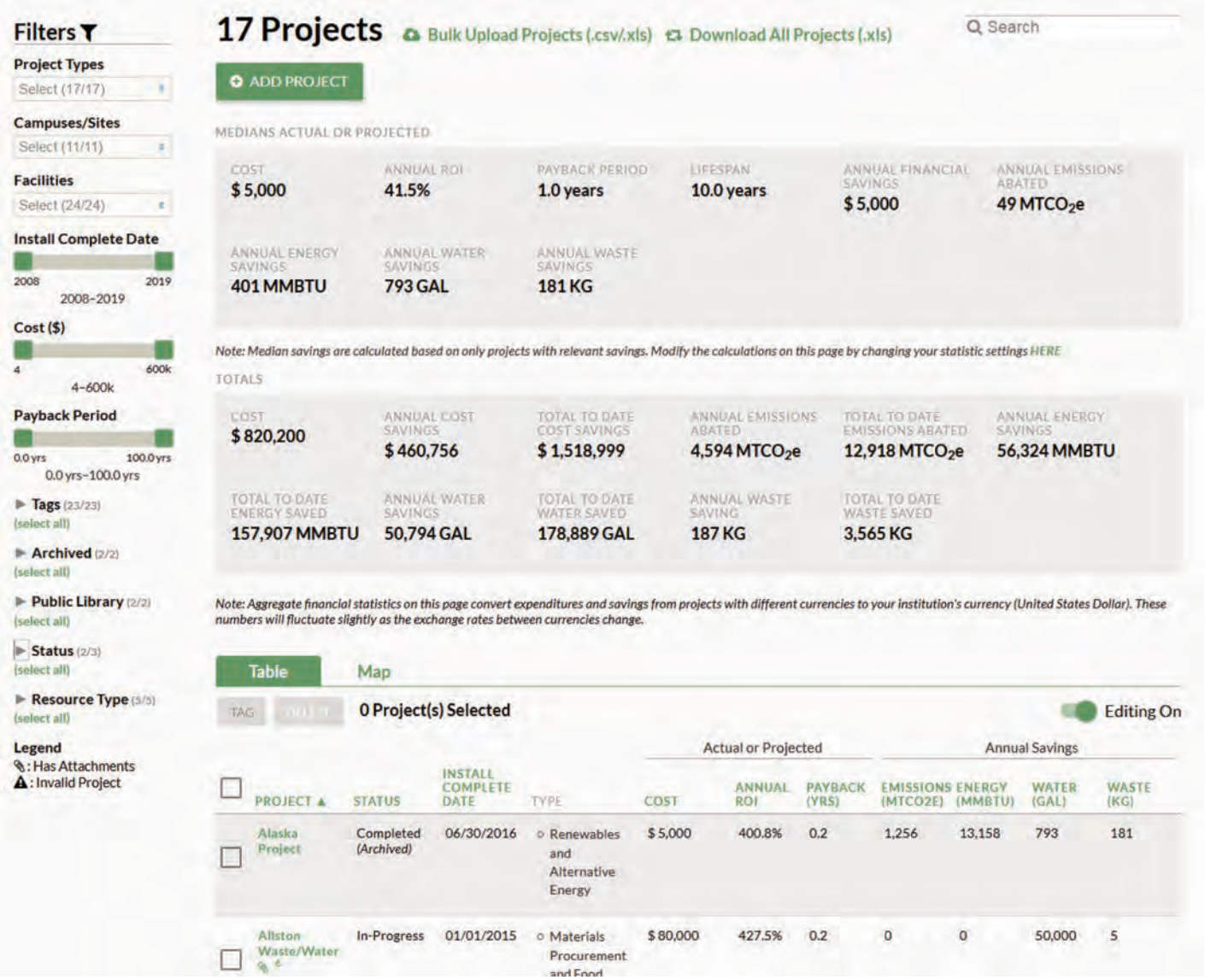

Figure 21. Project performance (featured with permission from SEI).

D2.2.2 Software Solutions

Pre-existing software solutions can be used in conjunction with an Excel-based spreadsheet approach, such as using energy tracking software to measure and aggregate energy use across a portfolio, or it can be used to manage the entire fund. At the time of writing this report, there was only one existing software package for GRF fund management (Sustainable Endowments Institute n.d.-k). This section describes optimal capabilities of GRF software regardless of product and service provider.

Software platforms allow for password-protected access to fund and project data by all stakeholders, who can collaboratively follow and manage the GRF. Online GRF platforms ideally are divided into several sections:

A **Dashboard page** presents the GRF's financial position, including the total fund value, outstanding project loans, and available balance. A mix of financial and environmental metrics calculated for projects funded to date, such as average annual ROI, average payback period,

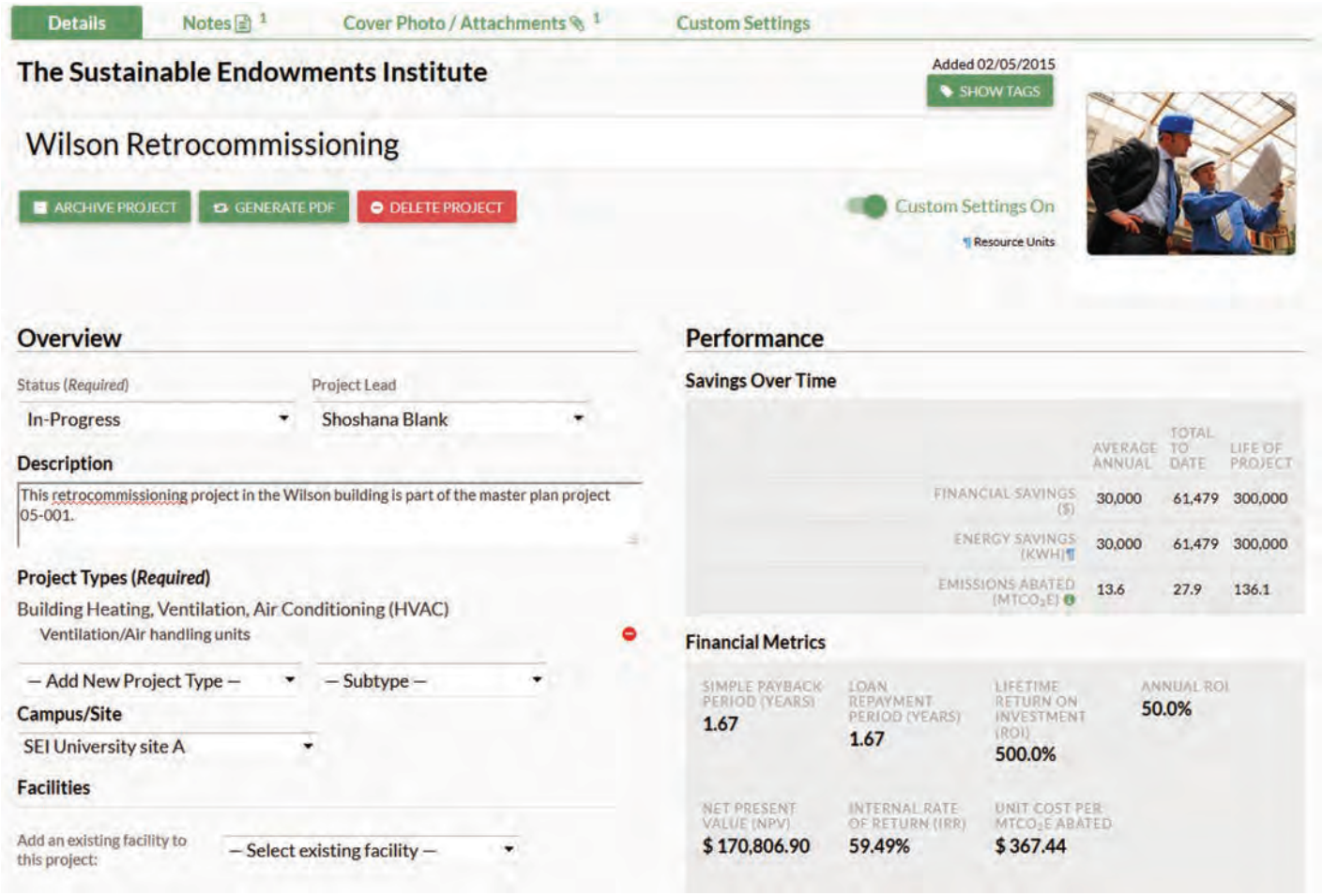

Figure 22. Performance report summary (featured with permission from SEI).

and energy/carbon/water/waste reduced to date, are displayed as well. This page is also where all financial flows are logged in a master ledger for the GRF. The Dashboard can list all the project-related expenditures and rebates, the project savings returned to the fund, and all non-project deposits and withdrawals organized in chronological order by fiscal year.

A **Projects page** displays all projects in a table that contains the project title, status (proposed, in-progress, or completed), project type, cost, and various savings metrics. The table can be converted into a map that depicts the location of the project facilities. Calculations made above the table of projects show a mix of averages for several characteristics (cost, payback period, ROI, and financial/energy/carbon savings) as well as totals (cumulative cost, total to date financial savings). Filters on this page allow you to isolate specific groups of projects by project type, facility, cost, or custom tags, among many other options. As you filter through your projects, ideally GRF-related software will automatically recalculate all the average and total metrics to present the impact of your selected group of investments. Because proposed projects are clearly delineated from in-progress and completed projects, isolating and evaluating proposed projects is straightforward.

A **Project Details page** contains all the qualitative and quantitative data for each project. The data entered by the user is organized on the left side of the page, including the project's description, project type, approval/completion timeline, and location of the project facilities. In Figure 21, the right side of the page features the calculations: energy/financial/carbon savings

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annually, to date, and over the project lifespan, followed by several financial metrics including payback period, ROI, NPV, and unit cost per metric ton of CO_2e abated. Below this information, there is a table that records the resource price and amount saved each fiscal year (data can be updated based on M&V) and informs the user about the amount of cost savings that should be returned to the GRF each year (based on the guidelines described on the Settings page). Notes and attachments (such as blueprints or before and after photos) can also be added to the project on the Project Details page. Ideally, all information can be shared either by generating it as a static document file or by sharing a web link that allows read-only access to anyone.

A **Reports page** allows users to build graphs and charts from their project data, visualizing the impact of their investments. You can build a solid bar graph showing savings accrued each year from all in-progress and completed projects, or have the bars split into color-coded pieces that relay the savings contribution from each individual project. Savings can also be graphed by facility, campus/site, project type, or by custom project groups. These options can be used to illustrate energy/water/waste savings, as well as financial and carbon savings. Other financially oriented graphs are available as well, including cash flow and expenditures. A table below the graph or chart displays the numerical information from which the figure is created. It may be useful if this information can be downloaded and included within reports to communicate the GRF's impact.

APPENDIX E

Sample Charter

The following charter has been adapted from documents found within the Sustainable Endowments Institute's Green Billion Sample Green Revolving Fund Documents (Green Billion n.d.).

Executive Summary

The purpose of the airport GRF is to serve as an ongoing mechanism for investing in facility energy efficiency, water and waste conservation, and renewable energy projects. The airport can use internal capital, grants, and other sources of capital to seed the revolving fund and make interest free internal loans to projects that reduce operating costs while lowering resource consumption and carbon emissions. The GRF can be managed by the airport GRF Committee.

About

A GRF is an internal investment vehicle that provides financing to parties within an organization for implementing energy efficiency, renewable energy, and other sustainability projects that generate cost-savings. These savings are tracked and used to replenish the fund for the next round of green investments, thus establishing a sustainable funding cycle while cutting operating costs and reducing environmental impact.

A GRF is an important tool for an airport to employ in its efforts to reduce energy use in its facilities and to meet an organization's public carbon footprint reduction goals.

Fund Establishment

Airports need to decide which airport line of business leads the GRF. Based on experience in other sectors (e.g., universities), the environmental affairs or sustainability department may be the most appropriate. The fund itself can be managed by the airport's financial operations department and overseen by the airport's GRF Committee (described in the Governance section).

Financial Structure

The fund provides capital for high-performance facilities design, operations, energy efficiency, and occupant behavior projects aimed at reducing the airport's carbon/environmental footprint and operating budget.

The GRF can be open to a wide range of projects from modest in size with a quick payback to larger projects with longer payback periods. While avoiding formal limits is suggested, the

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committee can generally concentrate on projects within a specific dollar range and payback period (many revolving funds use a range of $5,000 to $500,000 with a payback of 10 years or less). The project selection criteria may evolve over time, but the following criteria can be used to evaluate and prioritize projects under consideration:

- Payback period
- Resource conservation impact
- Carbon reduction potential
- Level of public visibility
- Schedule overlap with connected larger capital projects

Project feasibility—including energy savings, GHGs reduced, and ROI—can be analyzed with the help of internal facilities, planning and engineering staff, and third-party advisors.

Financial savings generated by resource conservation projects can be returned to the GRF until the initial investment is paid off. After the payback period is complete, a preset percentage of the annual savings generated from each project can be returned to the fund for the remaining useful life of the project/equipment (lifespan estimates typically provided by the manufacturer of equipment are often between 8 and 15 years, depending on the type of equipment installed) or until the fund reaches its dollar value goal, whichever comes first.

By tracking projects within a custom web platform for managing energy/financial/carbon data for GRF projects, this process can be simplified. Alternatively, a detailed and complex spreadsheet can be created to track overall GRF activity, as well as specific project data with numerous formulas to calculate annual as well as lifetime energy, financial, and carbon savings.

Funds for projects may be used for the following:

1. Materials or products that constitute the project—often the primary cost
2. Professional work, installation, or design related to project implementation
3. M&V equipment—costs can be minimized except on projects that exceed a preset amount

Typical projects include the following:

- High efficiency lighting/networked lighting
- Lighting and HVAC occupancy sensors
- High efficiency HVAC equipment and ductwork
- Controls for lighting and HVAC
- Insulation and air sealing
- Renewable energy
- Metering
- Cogeneration
- Water-saving plumbing fixtures

In general, projects that do not exceed a certain dollar amount (commonly $100,000 to $250,000 or another agreed upon threshold) can use engineering data to estimate cost savings, while larger projects may require installation of additional submetering systems to fully capture actual energy savings project performance data. The GRF Committee can decide whether exact or estimated savings are appropriate for each project.

If necessary, modified savings repayment plans may be designed or approved either from the start or later in a project's lifespan by consensus of the GRF Committee. For example, most GRF loans can be considered "full cost loans," meaning that the internal GRF loan can cover the entire cost of all materials, labor and other costs, such as consultants or metering equipment required to complete the project. In certain cases, when the organization is undertaking larger capital projects, the GRF Committee may choose to make an "incremental cost loan," whereby

the GRF would provide the difference in capital required between standard technology being installed and higher performance technology that uses less energy or water. In this case, the GRF is only providing a small piece of the overall project cost, which is specific to the upfront extra capital needed to invest in the higher efficiency technology. The savings paid back to the GRF would therefore be based on the engineering data calculating the energy/water saved estimation compared with either the existing equipment or the conventional replacement.

In all cases, project proposals can take advantage of local, regional, or federal incentives/rebates for EE/RE projects. When these incentives or rebates are received, 100% of the funds can be deposited into the GRF account for use in the next round of projects.

Governance

The airport GRF Committee can meet quarterly (or at a different predetermined interval) to authorize implementation of individual projects and review the M&V of projects completed to ensure that savings are adequately tracked and returned to the fund.

The committee can be made up of the following representatives:

Chair

- Planning/Environmental/Sustainability Director and Airport Director/CEO's representative

Members

- Financial Operations representative
- Planning representative
- Facilities Management representative
- Another Partner/Vendor representative

The committee may decide to solicit energy and resource conservation ideas from the greater airport community (e.g., tenants, the public) for consideration at committee meetings. Eligible projects must reduce resource use (electricity, natural gas, water, renewable energy) and generate financial savings over its lifetime that exceed the initial investment.

The committee can generate an annual report that outlines the impacts of the GRF during the current period and performance since inception. This report can be brief and generated in part through data from online software or other tracking methods, but it can also include a list of projects funded by the GRF. This report can be shared among internal and external stakeholders. The committee may amend this charter at any time by consensus.

APPENDIX F

Glossary

Airport Improvement Program

The Airport Improvement Program (AIP) is run by FAA under the U.S. DOT. Its broad objective is to help plan and develop a nationwide system of public-use airports that meets the current needs and the projected growth of civil aviation. AIP provides grants for a wide range of airport improvements including those that protect natural resources, which encompass energy efficiency and sustainability improvements. AIP grants are available nationally for all public-use airports in the National Plan of Integrated Airport Systems (NPIAS). Obtaining an AIP grant requires a grant application.

AIP funding is typically available for projects in four categories: Primary Entitlement Funding, Cargo Airport Entitlement Funding, Non-Primary Entitlement Funding, and Discretionary Funding (see Section 4.1.2).

Emissions & Generation Resource Integrated Database

"The Emissions & Generation Resource Integrated Database (eGRID) is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States." eGRID is issued by the EPA (U.S. Environmental Protection Agency n.d.).

Endowment Model

The endowment model refers to the funding mechanism for securing seed capital for a Green Revolving Fund (GRF). Under the endowment model, an amount of funding is dedicated for the express purpose of capitalizing a GRF. The benefit of this approach is that the fund is immediately able to finance new projects. The drawback is that a suitable source of funding must be identified, typically one that does not need to be repaid and is compatible with a GRF (see Section 3.2.1).

Energy Conservation Measures

Energy Conservation Measures (ECMs) are applied to a building to "improve energy efficiency and are life cycle cost-effective and involve energy conservation, cogeneration facilities, renewable energy sources, improvements in operations and maintenance, or retrofit activities" (U.S. Department of Energy 2013).

Fixed-Base Operator

"The term Fixed Base Operator (FBO) is given to a commercial enterprise that has been granted the right by an airport authority to operate on that airport and provide aviation services, such as fuel, parking and hangar space, to the General Aviation (GA) community"(SKYbrary n.d.).

Generally Accepted Accounting Principles

Generally Accepted Accounting Principles (GAAP) are accounting standards, conventions, and rules. They are what companies use to measure financial results. These results include net income, as well as how companies record assets and liabilities. In the United States, the Securities and Exchange Commission (SEC) has the authority to establish GAAP. However, the SEC has historically allowed the private sector to establish the guidance (U.S. Securities and Exchange Commission n.d.).

Green Revolving Fund

A green revolving fund (GRF) is an internal investment vehicle dedicated to financing energy efficiency, renewable energy, and other sustainability projects that generate cost savings. These savings are tracked and "revolved" back into the GRF, maintaining the funding stream for sustainability projects over time. GRFs are broadly defined by two criteria: (1) the fund must finance measures to reduce resource use (e.g., energy, water, or waste) or to reduce carbon emissions (e.g., by installing renewable energy technology); (2) the fund must revolve. Savings generated from operating cost reductions attributed to funded projects must be used to fully repay the initial loan or investment (see Section 1.1).

Green Revolving Investment Software Tracking System

There is an online platform designed to manage all aspects of an institution's GRF. The Sustainable Endowments Institute operates existing online software. Note that two authors of this report work at the Sustainable Endowments Institute. There is only one GRF management tool profiled in this report, because it was the only known operational example of its type at the time of writing this report (see Appendix D2.2).

GRF Charter

The management of fund operations involves a broad array of duties. Official and publicly available GRF charters are suggested. This document should clearly explain how the fund operates. Charters are often developed from a written proposal used as a forum for discussion during the funding design stage and may use much of the same language (see example included within Appendix E).

International Performance Measurement and Verification Protocol

One of the most widely recognized M&V documents is the International Performance Measurement and Verification Protocol (IPMVP). Efficiency Valuation Organization (EVO), a nonprofit corporation, assembles and oversees an IPMVP Committee of industry volunteers to

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develop and maintain the IPMVP. EVO publishes the documents. IPMVP provides guidance on developing and implementing M&V plans for energy and water savings projects. It provides a framework and guidance for developing specific M&V plans and describes considerations to be taken into account when developing an M&V plan (see Appendix D1.4).

Measurement and Verification

Measurement and verification (M&V) is the industry term for tracking and documenting savings and results of a GRF. M&V processes grew out of the energy efficiency and energy savings performance contracting industry and, as such, industry documentation and best practices are typically associated with energy savings projects. However, the principles of M&V can be applied to a variety of project types (see Appendix D).

Passenger Facility Charges

The Passenger Facility Charges (PFC) Program allows airports to collect a charge for enplaned passengers using the airport. Airports use this revenue to fund FAA-approved projects that enhance safety, security, or capacity; reduce noise; or increase air carrier competition. More than $2.2 billion in PFC revenues are collected by airport operators each year. PFC revenues are typically used on a "pay-as-you-go" basis, where PFC collections and interest earnings are spent directly on capital projects, and/or leveraged, that is, used to pay debt service on bonds or to repay other forms of debt (see Section 4.1.2).

Savings Reclamation Model

The savings reclamation model starts with a project (already identified and either being implemented or soon to be implemented) that will result in operational cost savings. The project owner then captures the resulting cost savings and uses those savings to capitalize the GRF (see Section 3.2.1).

Split Incentive

With utility conservation, split incentives refer to a situation in which the party that pays the resource bills (and thus realizes the benefits of efficiency upgrades) is not the owner of the building. With split incentives, the tenant that pays the bills does not want to invest in permanent improvements to a property it does not own, and the owner does not want to invest in improvements that only benefit the tenant. This same dynamic often pertains to airport-owned spaces that airline tenants operate. Split incentives create structural challenges to achieving the highest levels of energy efficiency (see Section 3.4.1).

State and Regional Technical Reference Manuals

Many states have implemented utility energy efficiency programs. To help standardize savings calculations across program participants, many of those states have developed documents that provide guidance on energy savings calculations (or the state participates in a regional effort). These documents are commonly referred to as Technical Reference Manuals (TRMs). Although not specifically related to the process of M&V, they do provide standardized methods for estimating energy savings from common energy efficiency measures. As a result, they provide an

excellent reference for potential energy efficiency measures and potential examples of savings calculation methodologies. TRMs are typically focused on measures that have relatively straightforward savings calculations and do not include "custom" measures (see Appendix D1.4).

Uniform Methods Project

The U.S. Department of Energy is currently developing a set of measurement and verification (M&V) protocols that will allow for consistent energy savings calculations for specific measures under the Uniform Methods Project (UMP) titled the Uniform Methods Project: Determining Energy Efficiency Program Savings. UMP provides specific savings calculation methodologies for common energy efficiency measures that are based on IPMVP recommendations. UMP provides measure descriptions, savings calculation methodologies, M&V considerations including IPMVP options, data requirements for M&V, and alternatives for lower-cost M&V options (see Appendix D1.4).

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
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
TDC	Transit Development Corporation
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

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