# Achieving Airport Carbon Neutrality

Volpe Center Report for the FAA Office of Airport Planning

Prepared for Federal Aviation Administration
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# Notice

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This report is a guide for airports that wish to reduce or eliminate greenhouse gas (GHG) emissions from existing buildings and operations. Reaching carbon neutrality typically requires the use of multiple mechanisms to first minimize energy consumption and then maximize renewable energy use. This report provides a flexible, step-by-step outline for planning and achieving airport carbon emissions reduction or neutrality. The steps include:

- Conducting background research and inventorying airport GHG emissions;
- Determining the scope of the carbon neutral airport project;
- Contracting with an energy services company (ESC);
- Implementing renewable energy; and
- Communicating project results.

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# Acronyms and Abbreviations

| Abbreviation | Term |
|---|---|
| ACA | Airport Carbon Accreditation Program |
| ACERT | Airport Carbon and Emissions Reporting Tool (Version 3.0) |
| ACI | Airports Council International |
| ACRP | Airport Cooperative Research Program |
| ACRP Report 11 | ACRP Report 11: Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories |
| AHP | Analytical Hierarchy Process |
| CFL | Compact Fluorescent Light |
| $CO_2$ | Carbon Dioxide |
| $CO_2e$ | Carbon Dioxide Equivalent |
| CREB | Clean Renewable Energy Bonds |
| CVEC | Cape and Vineyard Electric Cooperative |
| DOE | U.S. Department of Energy |
| ECM | Energy Conservation Measure |
| EPA | U.S. Environmental Protection Agency |
| ESA | Energy Services Agreement |
| ESC | Energy Services Company |
| ESPC | Energy Services Performance Contract |
| FAA | Federal Aviation Administration |
| FEMP | Federal Energy Management Program |
| FWS | U.S. Fish and Wildlife Service |
| GHG | Greenhouse Gas |
| GIS | Geographic Information System |
| HVAC | Heating Ventilation and Cooling |
| IGA | Investment Grade Audit |
| IPaC | Information for Planning and Conservation |
| IRS | Internal Revenue Service |
| LED | Light Emitting Diode |
| M&V | Measurement and Verification |
| MESA | Managed Energy Services Agreement |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NMFS | National Marine Fisheries Service |
| O&M | Operations and Maintenance |
| PACE | Property Assessed Clean Energy |
| PPA | Power Purchase Agreement |
| PPL | Plug and Process Loads |
| PV | Photovoltaic |
| REC | Renewable Energy Certificate |
| RFP | Request for Proposals |

| Abbreviation | Term |
|---|---|
| RFQ | Request for Qualifications |
| TCR | The Climate Registry |
| VALE | Voluntary Airport Low Emissions FAA Grant Program |
| WBCSD | World Business Council for Sustainable Development |
| WRI | World Resources Institute |

# Executive Summary

This report is a guide for airports that wish to reduce or eliminate net greenhouse gas (GHG) emissions from existing buildings and operations but have limited knowledge on how to do so. In many cases, airports are pursuing one of the mechanisms to achieve carbon neutrality, such as installing renewable energy or purchasing offsets, but are not taking advantage of the full suite of tools available to reduce GHG emissions and energy consumption. Reaching carbon neutrality typically requires the use of multiple mechanisms to first minimize energy consumption and then maximize renewable energy use. This report provides a flexible, step-by-step outline for planning and achieving airport carbon emissions reduction or neutrality. The steps include:

- Conducting background research and inventorying airport GHG emissions;
- Determining the scope of the carbon neutral airport project;
- Contracting with an energy services company (ESC);
- Implementing renewable energy; and
- Communicating project results.

An airport needs to carry out initial research and due diligence prior to initiating a carbon neutral airport project. This research may include a review of: the airport's existing contractual and financial obligations, potential conflicts with natural or cultural resources on airport property, and other potential barriers to an energy services contract or the siting of renewable energy facilities on airport land. Additionally, the airport should determine at the outset which scopes of carbon emissions to address in the neutrality project.

Once initial research is complete, the airport should select the best option for establishing an ESC contract to minimize energy consumption in a way that also minimizes upfront cost to the airport. In some cases such a contract can also be used to implement on-site renewable energy production. This report guides an airport through the steps of selecting a favorable ESC contract, including a comparison of the different contracting mechanisms; how to evaluate procurement methods and solicit a proposal; and how to select the best proposal and enter into the contract.

The ESC is responsible for implementing energy conservation measures (ECMs), which reduce the airport's energy consumption. However, as discussed in this manual, the airport should be in frequent communication with the ESC and any other entities that have jurisdiction to secure financing for the project. Should the airport wish to reduce electricity consumption from plug loads—which are not addressed by the ESC—this would be the airport's responsibility, and the workflow for this approach is discussed.

The ownership and financing of ECMs have significant implications for lifecycle cost, contractual obligations, and administrative burden. For example, if an airport elects to use an energy services agreement (ESA) or managed energy services agreement (MESA) contract to complete projects, financing will not be necessary. However, if an airport chooses to use an energy services performance contract (ESPC) or another mechanism, third-party financing may be necessary. This report discusses the implications and factors the airport may consider in choosing financing mechanisms.

In addition to ECMs, an airport may also consider pursuing on-site renewable energy production. In the primary model described in this report, the ESC is responsible for analyzing the potential for on-site generation, evaluating financing options, and completing all necessary permitting. However, if the ESC is not covering renewable energy as part of the contract, the airport would need to analyze all of this on its own. The report lays out a process for evaluating on-site renewable energy production potential, including how to use publicly available online estimation tools. Three types of renewable energy are evaluated: solar photovoltaic (PV), geothermal, and wind. The report discusses factors that the airport should consider in selecting sites for solar arrays, wind turbines, or geothermal wells. It also explains how to select financing mechanisms, issue requests for proposals (RFPs) for installation, and begin research on required permits.

On-site renewable energy generation and ECMs may not be enough to eliminate all carbon emissions. The report discusses additional options to reach carbon neutrality, such as the purchase of renewable energy credits (RECs), utility green pricing, and offsets. Finally, the report discusses other considerations, such as communicating the benefits of the carbon neutrality project to the public and certification options for airports that wish to certify to carbon neutrality.

# 1 Introduction

## 1.1 Research Purpose

This report is meant as a guide for airports that wish to reduce or eliminate greenhouse gas (GHG) emissions from existing buildings and operations, but have little knowledge of how to go about the process. The report does not address how airports should maintain carbon neutrality with expansion or additional building construction.

## 1.2 Background

More than 20 airports around the world have been accredited as "carbon neutral," which means on a net basis they produce no carbon emissions from airport operations over an annual period.[1] The majority of these carbon neutral airports are in Europe, with one airport each in India, Canada, and New Zealand.[2] No airports in North America have claimed or attained certification for carbon neutrality. However, U.S. airports have taken significant strides to reduce carbon emissions. Examples of these accomplishments include:

- San Francisco International Airport has a goal of achieving climate neutrality by 2025, reducing GHG emissions 40 percent from its 1990 baseline by 2025 and offsetting 100 percent of the remaining GHG emissions, and achieving LEED Gold certification for all new construction.[3]
- Denver International Airport generates 6 percent of its electricity on-site from three solar panel arrays that together total 45 acres and generate 13 million kilowatt hours (kWh) annually.[4]
- Barnstable Municipal Airport has installed a solar array of over 20 acres in size on airport property. The array is 6.7 megawatts in size and generates 7.9 million kWh of electricity annually.[5]
- Austin-Bergstrom International Airport is purchasing electricity generated by clean sources (certified by Green-e Energy), which eliminates GHG emissions from electricity used to power airport operations.

These and other significant achievements demonstrate the progress U.S. airports are making in reducing carbon emissions.

This report provides a step-by-step outline for planning and achieving airport carbon neutrality. The steps include:

- Inventorying airport GHG emissions;
- Determining the scope of the carbon neutral airport project;
- Contracting with an energy services company (ESC);
- Implementing renewable energy; and

[1] www.airportcarbonaccreditation.org/airport/participants.html
[2] Cochin International Airport in Kochi, India announced plans to become the world's first "solar" airport meaning, once implemented, all airport operations will be powered by a solar array installed on-site."[2]
[3] http://aci-na.org/sites/default/files/esmaili_sfo_sustainability_guidelines.pdf
[4] http://business.flydenver.com/community/enviro/documents/sustainReport2013.pdf
[5] www.barnstable-airport.com/airport/AP-Final-SolarFAQ4-22-15.pdf

- Communicating project results.

This outline is not intended to be prescriptive and offers airports flexibility in implementing their carbon reduction or neutrality programs.

### 1.2.1 Existing Resources

A number of sources provide information on the use of renewable energy and reducing carbon emissions at airports. *Airport Cooperative Research Program (ACRP) Report 11: Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories* provides guidance on the preparation of airport GHG inventories.[6] *ACRP 141: Renewable Energy as an Airport Revenue Source* provides an overview of the procurement and financing process for airports interested in pursuing renewable energy.[7] Another ACRP report currently in publication will address financing mechanisms for renewable energy.[8] *ACRP Report 57: The Carbon Market: A Primer for Airports*[9] provides the airport community with information on carbon and other environmental credit trading markets, potential opportunities, and challenges to airport participation in these markets. In addition, *FAA Technical Guidance for Evaluating Selected Solar Technologies on Airports* (November 2010) clarifies the Federal Aviation Administration (FAA) review process, presents information on solar energy, and describes financial opportunities. Finally, the Airport Council International (ACI) Airport Carbon Accreditation program (ACA) has established a mechanism for airports to certify to carbon neutrality.[10]

This report aims to add to these resources by providing an overview of how to implement a carbon neutral airport project based on a real-world project.

### 1.2.2 Summary of Previous Volpe Reports on Airport GHG Inventories

The project team has previously submitted four reports to the FAA summarizing research and original analyses on airport GHG inventory methods:

- The first task report examined the voluntary and mandatory requirements domestically and abroad for GHG emissions inventory reporting.[11] It identified airport emissions types and sources, and available methodologies for data collection and reporting GHG inventories.
- The second task report focused on airport-specific GHG reporting protocols, tools, scales, and metrics.[12]

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[6] *ACRP 11 Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*, Transportation Research Board, 2009
[7] Transportation Research Board. *ACRP Report 141 Renewable Energy as an Airport Revenue Source*, August, 2015 http://onlinepubs.trb.org/Onlinepubs/acrp/acrp_rpt_141.pdf
[8] Project 02-56: "Developing the Airport Business Case for Renewable Energy" (final deliverable being prepared) http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3702
[9] http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_057.pdf
[10] www.theclimateregistry.org/ and www.airportcarbonaccreditation.org/
[11] Volpe, "FAA Airports Greenhouse Gas Reporting Schemes," October 2013 (Volpe, 2013a)
[12] Volpe, "FAA Airports Greenhouse Gas Reporting Schemes," November 2013 (Volpe 2013b)

- The third task report described an analysis of Scope 1 and Scope 2 airport GHG emissions based on energy consumption data that staff from six airports provided.[13] It also contained detailed interviews conducted with airport staff regarding their efforts to develop their respective airports' initial GHG inventories. An assessment of how different airport characteristics, such as enplanements, climate, and facility area may be correlated with GHG emissions intensity, was presented.
- The fourth and fifth task reports compared various methods for inventorying Scope 3 airport GHG emissions and assessed the data needs and accuracies of the identified approaches.[14] Best practices for Scope 3 GHG emissions inventory development and reporting were recommended.

### 1.2.3 FAA Assistance to Airports on Reaching Carbon Reduction Goals

The FAA Sustainability Grants Pilot Program[15] enabled a diverse set of 44 airports[16] to develop Sustainability Master or Management Plans that include explicit GHG inventories, as well as emission reduction targets and activities.

### 1.2.4 Need for this Guide

In many cases, airports are undertaking one of the mechanisms needed to achieve carbon neutrality, such as installing renewable energy or purchasing offsets, but are not taking full advantage of the suite of resources available to reduce GHG emissions and energy consumption. Reaching carbon neutrality requires the use of multiple mechanisms to first maximize energy savings and then maximize renewable energy. Offsets may also be needed to reduce any remaining carbon emissions. To date, a step-by-step guide to reaching carbon neutrality for airport operations has not been available. This report attempts to fill that gap. Additionally, the report provides a centralized source for information needed when undertaking a carbon neutral airport project—such as the specific energy contracting mechanisms provided in different states and a sample request for proposals (RFP) for an ESC contract.

### 1.2.5 Report Organization

The process for reaching carbon neutrality at airports can be implemented in five main steps; this report is organized around these steps:

- Chapter 2 describes initial research that an airport should undertake prior to initiating a carbon neutral airport project. This research includes an evaluation of existing contractual and financial obligations, existence of endangered species on airport property, historical preservation designations, and other necessary considerations.

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[13] Volpe, "Developing Airport Baseline Greenhouse Gas Inventories: The First Step to Airport Carbon Neutrality," October 2014 (Volpe, 2014)
[14] Volpe, Airport Greenhouse Gas Inventories: Assessing Tenant Related Activities, March 2015 (Volpe, 2015a)
[15] Additional information on FAA's work to support sustainability planning is available at www.faa.gov/airports/environmental/sustainability/.
[16] See list at www.faa.gov/airports/environmental/sustainability/

- Chapter 3 details the steps the airport will take to establish an energy services contract that reduces airport energy consumption and GHG emissions.
- Chapter 4 describes the process for quantifying energy and cost savings from energy conservation measures energy conservation measures (ECMs).
- Chapter 5 provides a description of how to estimate the potential of renewable energy sources on airport property.
- Chapter 6 details mechanisms for financing on-airport renewable energy and ECMs.
- Chapter 7 describes how an airport can address any remaining GHG emissions in order to reach carbon neutrality.
- Chapter 8 discusses considerations such as communicating the benefits of the program and certification options for airports that wish to certify to carbon neutrality.

A number of appendices to this report provide additional information and resources:

- Appendix A provides a list of designations for priority habitat for all airports in a sample state.
- Appendix B is a state-by-state reference guide on legal requirements for establishing contracts with energy services companies.
- Appendix C is an example RFP that airports can use in developing their own request for energy services performance contract proposals.
- Appendix D is a decision tree detailing a request for qualifications (RFQ) as opposed to an RFP process.
- Appendix E is a net present value example for ECMs.
- Appendix F describes a process that can be used to weight criteria and make decisions at any point in the carbon neutral airport program.
- Appendix G provides a guide to developing an RFP for renewable energy at an airport.

# 2 Getting Started

An airport needs to undertake a number of preliminary steps before initiating a carbon reduction or neutrality project. As a first step, airport staff should familiarize themselves with the major steps in the carbon neutral airport process and develop a list of areas to research prior to beginning the program. This chapter summarizes the major steps in the process of achieving carbon neutrality and then outlines some areas that are particularly important to research.

## 2.1 Steps in the Carbon Neutral Airport Process

There are six basic steps in the carbon neutral airport process:

(1) Designate staff;
(2) Conduct initial research;
(3) Contract with an energy services company;
(4) Select renewables;
(5) Implement ECMs and renewable energy; and, if needed,
(6) Select additional carbon reduction measures.

Figure 1 illustrates the steps in the process. In the figure, blue boxes represent efforts that the airport leads; orange boxes are led by an ESC with input from the airport; and green boxes are initiatives which the ESC undertakes and is responsible for. In this model, the airport: (1) selects staff to oversee the carbon neutral program; (2) conducts initial research; (3) establishes a contract with an ESC; and (4) selects any carbon offsets at the end of the project, if needed.

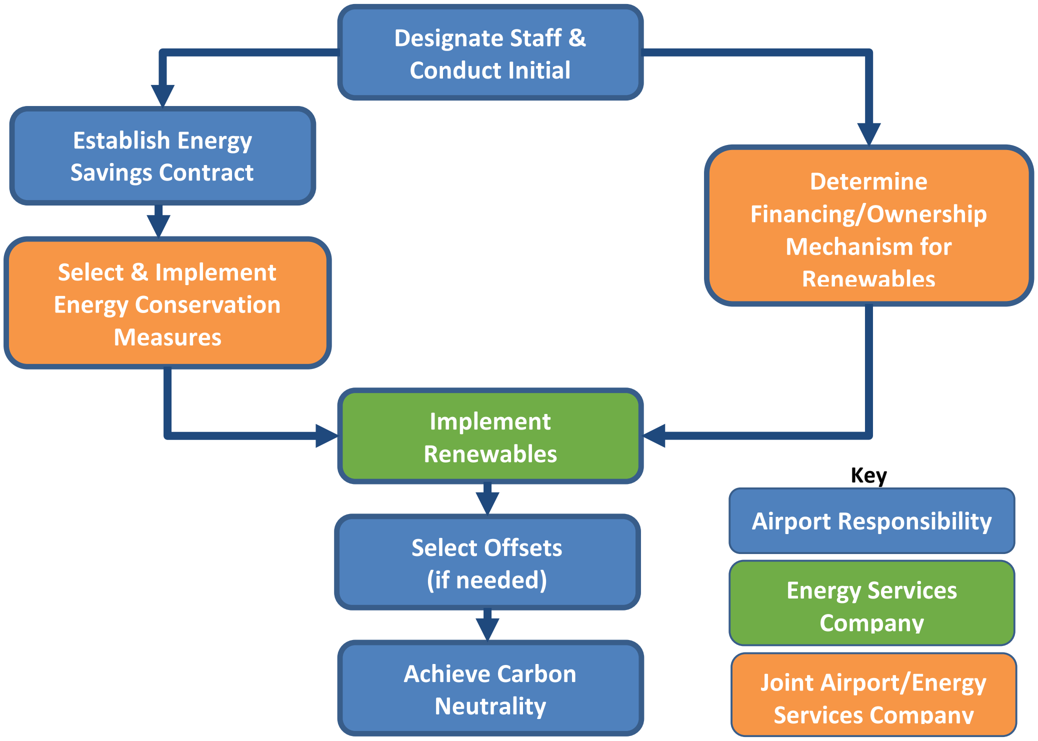



**Figure 1. Carbon Neutral Airport Process Steps**

The ESC is responsible for: (1) evaluating and implementing ECMs; (2) assessing the potential of renewable energy at the airport; and (3) establishing renewable energy. In addition, the ESC is responsible for assisting in determining financing mechanisms for renewable energy, although the airport plays a key role in making decisions on these topics.

While this report relies on the above-described approach to reach carbon neutrality, airports could choose to leave out elements of this approach. For example, an airport could choose not to contract with an ESC and instead rely on installed renewable energy for all carbon reductions. Another approach would be to install no on-site renewable energy and instead rely on a combination of energy-saving measures and/or offsets to reach carbon neutrality. Most of the existing carbon neutral airports have achieved carbon neutrality using only offsets, so this is a common approach.

Another factor that could alter responsibilities in the above model is the structure of the energy services contract. More specifically, the airport may not receive proposals from ESCs willing to take on the renewable energy aspects of the project. If this is the case, the airport will need either to take on the assessment of renewable energy potential and the implementation of renewable energy, or skip that step in the carbon neutral process.

The remainder of this chapter addresses the first box in Figure 1, conducting initial due diligence for the carbon neutral project. The necessary questions are described, followed by an explanation of related resources for airports.

## 2.2 Conduct Initial Research

Assuming the airport has selected staff to work on the carbon neutral airport project, the next step is to conduct initial research. Conducting initial research into three areas prior to undertaking any more detailed analysis is important for program success. The research will help define the scope of the project and identify constraints and opportunities, including an understanding of the contracting mechanisms allowed in the airport's state.

### 2.2.1 Review Existing Financial and Contractual Obligations

Depending on the financing mechanisms that are used to support a carbon neutral airport program, investment from the municipality, county, or state may be involved. For example, a town bond may be required to back the upfront costs of the carbon neutral program, to be repaid over the program period. As part of the preliminary research and due diligence, an airport should identify at the outset any existing financial obligations that involve these potential financing partners, such as outstanding loans, land transfers, or other constraints. If any obligations exist, they should be documented, and a dialogue should be opened to determine as early as possible whether certain financing mechanisms (e.g., a municipal bond) will be infeasible.

Existing contractual obligations should also be evaluated. For example, if land on the airport is leased or is expected to soon be leased, then the parcel of land should be removed from consideration for locating renewable energy sources. Another example would be an existing ESC contract that remains in effect. Should such a contract be in effect then it is unlikely that the airport could consider entering into another ESC contract until the term expires.

### 2.2.2 Identify Potential Conflicts with Protected Resources

Federal or state laws and regulations may pose an obstacle for proposed on-site renewable energy installations if those projects have the potential to impact protected aspects of the human or natural environment. Examples of protected categories may include but are not limited to: imperiled species and their critical habitats, cultural resources, or water resources. It is advisable to check for potential conflicts very early in the consideration of ground-mounted, on-site renewables, otherwise a conflict late in the process could render a project infeasible and waste considerable time and expense. Should conflicts exist, renewable energy installation is not necessarily ruled out, but it may limit installation to rooftops or other areas that are not ground mounted. The due diligence required prior to undertaking a renewable energy project on airport land includes: evaluation of any existing contractual arrangements; the potential for protected ecosystems to exist on airport property; and/or identification of historic preservation or other ordinances limiting placement of renewable energy sources.

In many instances, protected resources are mapped, which can facilitate the initial screening process by allowing a project proponent to consult geographic information system (GIS) data layers for potential conflicts.

Federal examples of such data sources include:

- Information for Planning and Conservation (IPaC), which is relevant for endangered species and critical habitats (https://ecos.fws.gov/ipac/)
- National Wetlands Inventory (www.fws.gov/wetlands/)

States also often provide resource information in a publicly accessible statewide geographic information system (GIS) data clearinghouse**.** The Federal Highway Administration (FHWA) website provides a partial list of state GIS data clearinghouses, along with descriptions of what each contains.[17] It also provides a few examples of states that provide web-based screening tools for transportation projects.[18] Additionally, the Massachusetts Institute of Technology maintains a website with links to state-level websites with GIS data, which may include protected resource layers.[19]

#### *2.2.2.1 Rare Species*

##### 2.2.2.1.1 Federal protection

The Federal Endangered Species Act of 1973 (ESA) protects endangered species from extinction as a "consequence of economic growth and development untempered by adequate concern and conservation." The Act makes it unlawful for a person to "take" a "listed" animal without a permit. "Listed" means that the U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS) has identified a particular species as threatened or endangered. "Take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Through regulations, the term "harm" is further defined as "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." Listed plants are not protected from "take," although it is illegal to collect or maliciously harm them on Federal land or through Federal actions. The Act does not completely prohibit any "take" of listed species; instead, it requires a consultation with either FWS or NMFS, and the issuance of a permit from one of those agencies prior to any "take."[20]

The Act, as amended, requires FWS and NMFS to designate "critical habitat" zones for all species listed as threatened or endangered. All Federal agencies are prohibited from authorizing, funding, or carrying out actions that "destroy or adversely modify" critical habitats. While the regulatory aspect of critical habitat does not apply directly to non-Federal landowners, any development that would require a Federal permit indirectly also becomes subject to critical habitat regulations.

IPaC is a tool created by FWS that allows users to reference whether any threatened or endangered species, critical habitat, migratory birds, or other natural resources may be impacted by a project.[21] Users can enter a

[17] See www.gis.fhwa.dot.gov/gdc_datalibraries.asp
[18] See www.gis.fhwa.dot.gov/gdc_tools.asp
[19] http://libguides.mit.edu/c.php?g=176295&p=1161385
[20] www.fws.gov/endangered/esa-library/pdf/ESA_basics.pdf
[21] See https://ecos.fws.gov/ipac/

project location by uploading a GIS shapefile, or by simply drawing a polygon or line on an interactive map. The system then generates a resource list, which informs the user whether any threatened or endangered species, designated or proposed critical habitats, Migratory Birds of Conservation Concern, or other natural resources of concern may be affected by the project. If there are potential impacts, the user can enter additional project details and the system will analyze what the impacts are likely to be, providing design recommendations for addressing them. The project proponents should then contact the local FWS or NMFS field office to ask whether an official consultation will be necessary.

#### 2.2.2.1.2 State-specific protection

The ESA also provides funding for state wildlife agencies to develop programs for management of threatened and endangered species and to prepare lists of endangered and threatened species within their respective state boundaries. These state lists often include species which are not included on the national list of endangered and threatened species. In addition, 46 states have their own state-specific endangered species acts. However, Massachusetts has the only state act that parallels the Federal Act in that it includes habitat modification in the definition of "take," and prohibits the unauthorized alteration of significant habitat. The majority of state endangered species acts narrowly define "take" to include only harvesting, actually injuring, or capturing listed species. Some states, such as Nebraska and California, have statutory or regulatory language that might be construed to prohibit habitat modification, but the implementing agencies have chosen not to interpret it that way. Six states (California, Hawaii, Illinois, Massachusetts, Maine, and Wisconsin) permit incidental "take" of listed species if individuals proposing to alter significant habitat submit detailed mitigation plans.[22]

In Massachusetts, the Natural Heritage and Endangered Species Program defines regions of the state as priority or critical habitat for a range of species, and most of the state's airports coincide with these. Appendix A provides a list of designations for all Massachusetts airports. Constructing solar arrays or other renewable resources in these habitats is possible but requires additional permitting and either financial or land-swap forms of mitigation. Required mitigation both extends the project schedule and financial payback. Thus, siting for renewables should be selected to avoid this condition, if possible, and if not, the estimated mitigation costs should be considered upfront. It is critical to engage the airport's environmental lead early in the planning stages and to review state and Federal habitat designations that could affect the choice of siting.

### *2.2.2.2 Wetlands*

On the Federal level, the U.S. Army Corps of Engineers is the agency that regulates wetlands disturbing activities. It does so under the Clean Water Act, Section 401 or 404, and the Rivers and Harbors Act, Section 10. Some states and local agencies regulate, but do not necessarily prohibit, development that would impact wetlands. Typically, a person or organization planning an activity that would disturb wetlands must obtain wetlands permits from the agency (or agencies) in question before beginning the project. The National

[22] Bauer, D., Irvin, W.M.R., "Endangered Species Act: Law, Policy, and Perspectives, Second Edition," 2010 www.biologicaldiversity.org/publications/papers/StateEndangeredSpeciesActs.pdf

Wetlands Inventory, maintained by FWS, may be useful for project proponents as an initial screening tool to determine the potential for wetland impacts.[23] State- or local-level data sources may also be able to provide more granular data on the geographic extent of wetlands.

#### *2.2.2.3 Cultural Resources*

The National Historic Preservation Act (NHPA) is a law intended to preserve historical and archaeological sites in the U.S. Among other things, the NHPA requires Federal agencies to evaluate the impact of all federally funded or permitted projects on historic properties (buildings, archaeological sites, etc.) through a process known as Section 106 Review. The National Environmental Policy Act (NEPA) extends the potential reach of the NHPA, because the scope of the NEPA analysis must include the environment around a project, which may include a historic site. The Section 106 review process includes historic resources eligible for listing, not just those already on the National Register of Historic Places. Individual states have a variety of different regulations to protect cultural resources. The best way to proactively avoid conflicts associated with a project would be to contact the State Historic Preservation Office for the state in question. A list of the websites for these respective offices is available online.[24] In addition, airports should check with municipalities to find out if restrictions exist.

### 2.2.3 Determine GHG Sources to Include in the Carbon Reduction Program

After the airport considers potential conflicts with protected resources and constraints related to existing financial obligations, the next step is to determine which GHG emissions to include in the carbon neutral program. An airport may do this on its own or wait until the energy services contract is in place to evaluate scopes. Should an airport wish to do this first, at a minimum, sources that are directly controlled by the airport, also called Scope 1 emissions, should be included in the program.

Scope 1 sources are GHG emissions related to stationary combustion of airport-owned boilers, furnaces, or generators. Fuel used in vehicles owned and operated by the airport is also part of Scope 1 emissions. For consistency with other airport carbon reduction or neutrality programs, it is advisable also to include Scope 2 sources, or those emissions indirectly controlled by the airport (through purchasing and use), but produced offsite. The World Resources Institute (WRI) GHG Protocol recommends that the sources shown in Table 1 be included in Scope 1 and 2 inventories. Not all of these sources will be present or relevant to all airports.

The most significant choice is whether to include some or all Scope 3 emissions, those not controlled or produced by the airport but associated with its operations. Aircraft and other tenant emissions as well as ground-access vehicles fall into Scope 3. Excluding Scope 3 greatly increases the feasibility of attaining carbon neutrality and of being able to make the carbon neutral claim. However, the technical nuance of carbon neutrality for only airport-controlled emissions may require some public outreach and education to be duly recognized. It is important to note that none of the carbon neutral airports worldwide have included Scope 3

[23] See www.fws.gov/wetlands/
[24] See www.nps.gov/nr/shpolist.htm

emissions to date. Absolute carbon reductions achieved will obviously be higher if Scope 3 airports emissions sources are also reduced, which would allow the airport to emphasize the avoided GHG tonnage in public outreach.

**Table 1. Sources Generally Included in Scope 1 and 2 Emissions**

| Sources Generally Included | Scope |
| --- | --- |
| Stationary combustion (airport-owned and controlled electricity, heat, and steam) | 1 |
| Mobile fossil fuel (airport-owned and controlled vehicles, aircraft, and ground service equipment) | 1 |
| Fluorinated gases (HFCs, PFCs, $SF_6$) | 1 |
| Wastewater treatment, solid waste landfill, other fugitive and process emissions (airport-owned and controlled) | 1 |
| Purchased electricity, steam, hot water, chilled water, steam from waste, combined heating and power | 2 |

### 2.2.4 Consult Relevant State Regulations on Energy Savings Contracts

An important component of a carbon neutral airport project is engaging an energy services company. With few exceptions, states have established legal requirements for public airports entering into a contract with an ESC. Privately owned airports are not subject to these requirements. For publicly owned airports, understanding the procurement process and contract term requirements is a necessary first step in establishing the energy services contract. A discussion of requirements is provided below, and Appendix B summarizes all 50 states' requirements and links to legislation in each state.

Most state and local government-owned airports are allowed to use performance contracting to acquire building upgrades and energy efficiency improvements. A review of enabling legislation for each state revealed that in states where performance contracting is allowed, there is consistency in the qualifying efficiency measures. For example, insulation, energy control and recovery systems, and lighting upgrades are encouraged. In a majority of states, the term for performance contracts is generally 20 years, but a range of allowable contract terms exists. RFPs and lease purchase agreements are the procurement methods and funding mechanisms, respectively, specified in most states. States have varying offices and administrations responsible for reviewing proposals or contracts.

It is worth noting that rarely are the terms "Energy Services Performance Contract" (ESPC) or "Energy Services Agreement" (ESA) ("shared savings contract") specifically named. Instead, the enabling legislation is worded in general terms, such that they would conceivably allow a contract under either of those models, discussed in sections 3.1.1 and 3.1.2, respectively. In other words, an airport should not rule out using an ESA just because it is not specifically referenced.

Most of the authorizing regulations are applicable to both state and local agencies, but a few are only applicable to state agencies, so a public airport will need to consider the "applicability" column of the table in Appendix B to ensure relevancy. Approximately one-third of airports in the U.S. are publicly owned (Figure 2). As stated above, privately owned airports do not need to comply with authorizing regulations specific to public agencies and can more freely enter into energy services contracts. However, privately owned airports may still benefit from reviewing the regulations, as it may help them to consider what terms they may desire in a contract.

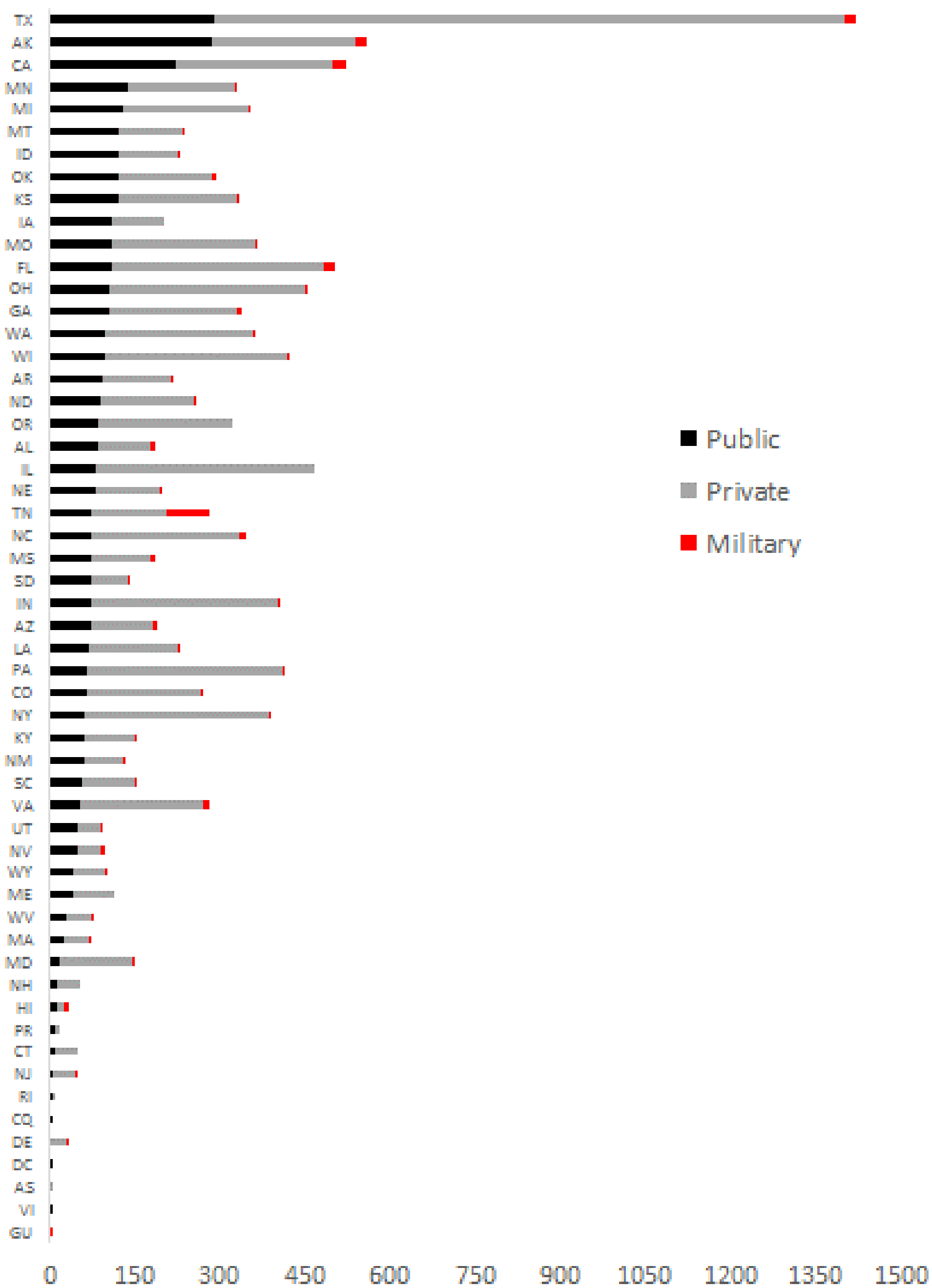



**Figure 2. Airport Ownership in the United States**

The next chapter describes the process for putting the energy services contract in place.

# 3 Establish an Energy Services Contract

After an airport has researched whether it can enter into an energy services contract (ESC) and determined whether there are significant obstacles to on-site renewable energy, the airport is ready to contract with an ESC. The purpose of establishing an energy services contract is to reduce energy consumption at the airport to the lowest possible level in a way that minimizes the upfront cost to the airport. Additionally, some energy services contractors will also assess on-site renewable energy potential and implement renewable energy, thus significantly reducing the level of effort for the airport.

There are three main steps for entering into an energy services contract: understand the different contracting mechanisms and choose the best approach for the airport; evaluate procurement methods and solicit a proposal from energy services contractors; and select the best proposal and enter into a contract. These steps are described in the sections that follow and are also mapped out in Figure 3.

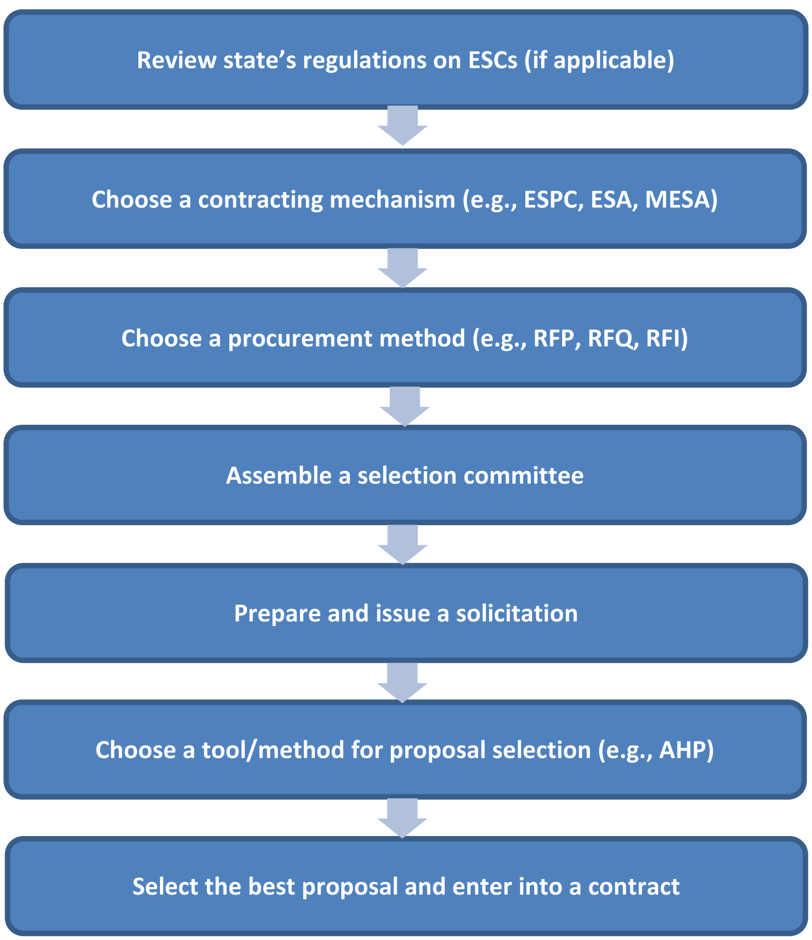



**Figure 3. Process for Establishing an Energy Services Contract**

## 3.1 Determine the Best Contracting Mechanism for the Airport

There are three main models for energy services contracts. Currently, the most common contracting mechanism that government and nonprofit entities use for energy efficiency improvements is the energy services performance contract (ESPC). Recently, more public and nonprofit property owners have begun examining and using alternative approaches to the ESPC model, such as an energy services agreement (ESA) or a managed energy services agreement (MESA). Each contracting mechanism has different arrangements for how and when the cash flows from energy savings are shared among an ESC, a finance provider, and an airport. The section that follows describes the basic principles of an energy services contract, followed by a discussion of the differences between the ESPC, MESA, and ESA models.

ESPCs, MESAs, and ESAs differ from the traditional design/bid/build model. The traditional model tends to follow the following steps, which are represented graphically in Figure 4:

1. Conduct a study;
2. Hire an architectural and engineering firm;
3. Establish a budget;
4. Seek capital funding;
5. Request bids;
6. Award to a general contractor;
7. Assign a construction manager; and
8. Process change orders, and potentially have to deal with finger-pointing in disputes.

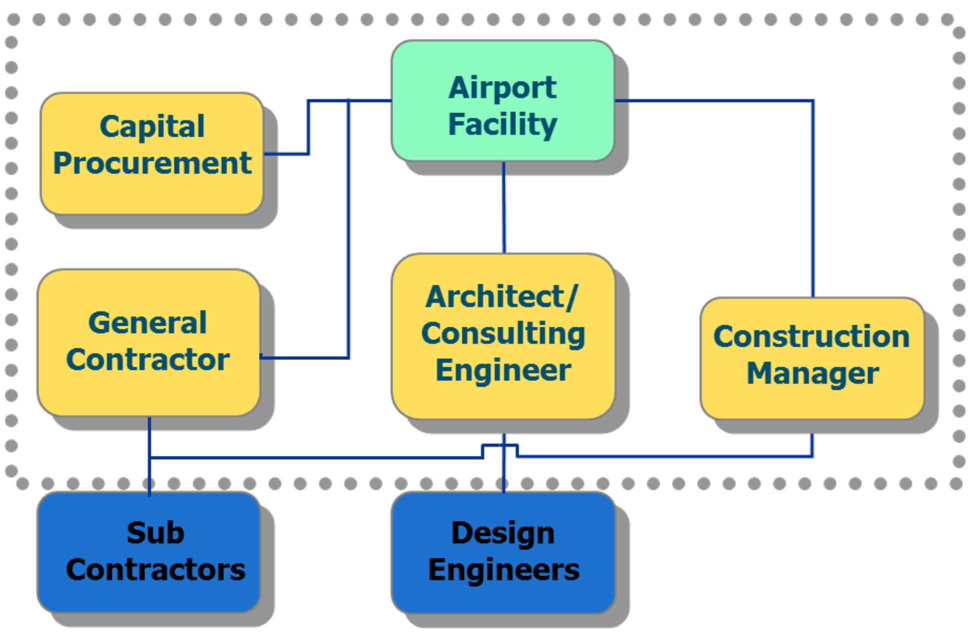



**Figure 4. Process Required in a Traditional Design/Bid/Build Process**

In the traditional design/bid/build process as shown in the figure, the airport is responsible for all the activities inside the gray dotted line. In this model, the airport is responsible for hiring a general contractor, an architect, and a construction manager in addition to obtaining financing for the project. Energy savings for the project would not be guaranteed by any of these contractors.

By contrast, the process and working framework in an energy services contract is much simpler from the perspective of the airport facility. Figure 5 illustrates this, by representing the ESPC, MESA, and ESA processes. In this framework, the ESC and/or project developer provides one-stop shopping for all work (e.g., audit, design, construction, measurement and verification (M&V)), and the project liability lies with the ESC/project developer. This is indicated by the gray dotted line showing the airport-only contracts with one entity—the energy services company. Within an ESPC, even if the ESC does not provide direct financing, they often assist the airport facility with financing procurement (indicated by the dashed line in the figure). Within an ESA or MESA, the ESC funds all investments. Therefore, these ESC projects tend to be turnkey projects and avoid the potential finger pointing that can occur with a traditional design/bid/build model. Perhaps most importantly, the ESC/project developer guarantees the savings that pay for the project, leaving relatively little risk for the airport. Most state regulations on ESC contracts require that the ESC guarantee the level of savings that the project will achieve.

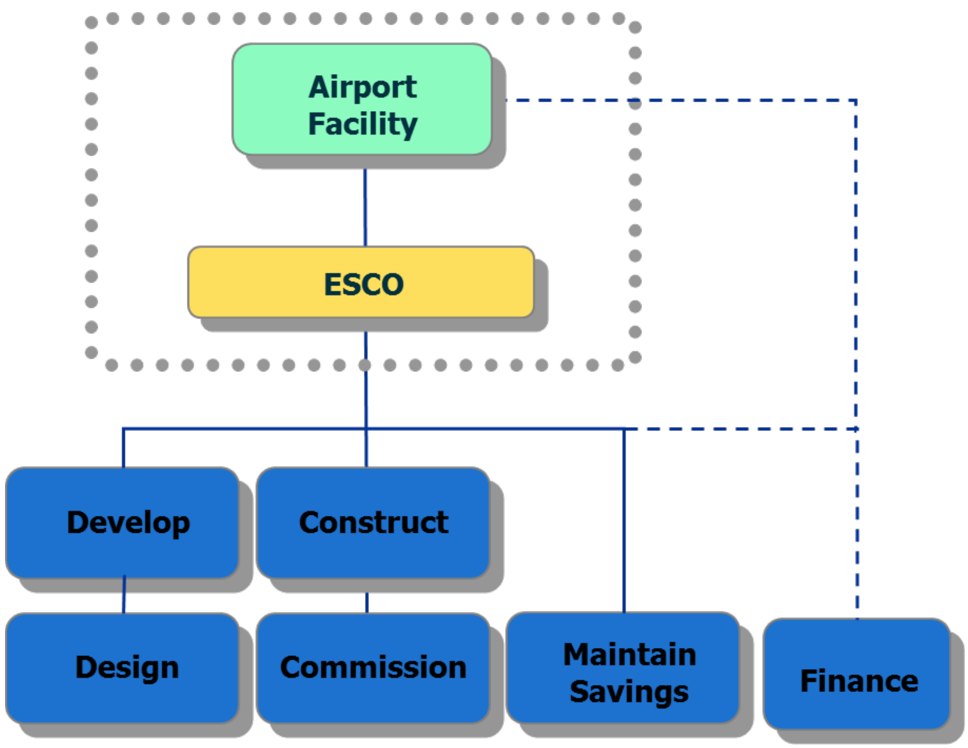



**Figure 5. Airport Responsibilities in an Energy Services Contract Arrangement**

Now we will provide more detail on the three different types of energy services contracts and highlight the differences between the mechanisms.

### 3.1.1 Energy Services Performance Contract

The ESPC is a design-build, fixed-price contract between a customer organization and an ESC using a "pay from savings" model to pay for energy and water conservation upgrades. In other words, the savings from the energy upgrades are guaranteed to outweigh the total costs of the project. Figure 6 illustrates how utility and other energy-related payments are made before and after an energy services contract is established.

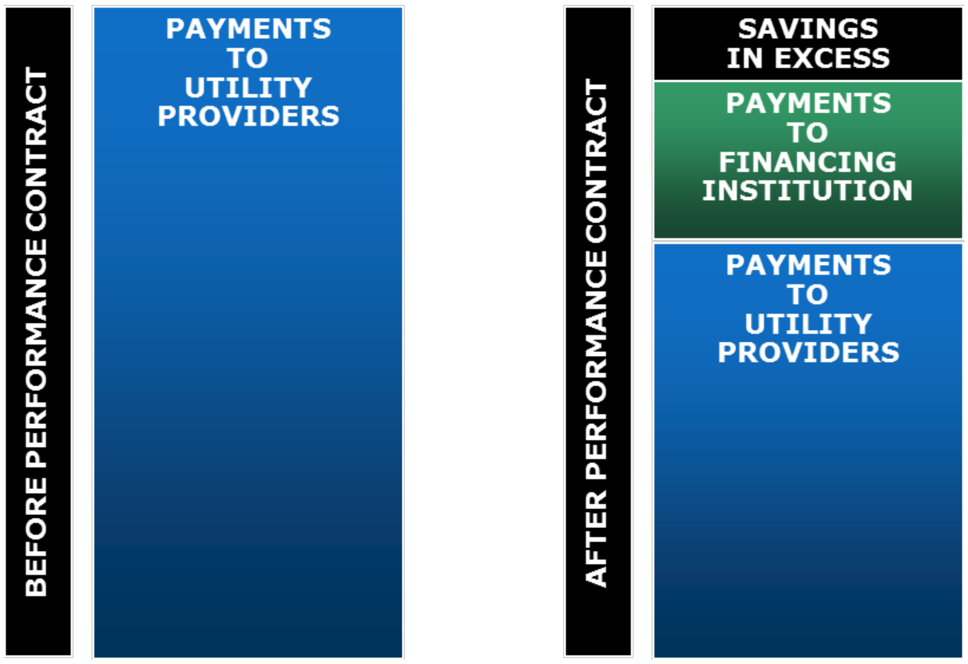



**Figure 6. Difference in Energy-Related Payments Before and After Performance Contract Is Established**

On the left, the entire utility bill is paid directly to the utilities. These same funds are distributed differently after a performance contract is in place as is shown on the right, including the possibility of savings in excess of what is budgeted for energy spending.[25]

In this example, the airport benefits from new, energy-efficient equipment and infrastructure and reduced carbon emissions; the only cost is the need to maintain the same level of utility spending already budgeted. Thus, if the ESC guarantees a savings of $40,000 as part of the ESPC, but the actual utility bill falls by $50,000 after the $40,000 in savings is paid to the ESC or financing institution, the airport facility can keep the extra $10,000 as banked savings. Finally, if the ESC guarantees savings of $60,000 but the actual utility bill only falls by $50,000, then the ESC is obligated to reimburse the airport by lowering the payment required by $10,000. Overall, there is the potential for net income to the airport facility with very little risk, all while reducing the facility's carbon emissions. Figure 7 shows the basic structure for an ESPC and the relationships between the parties.

[25] In Figure 6, the term "utility" is meant to include not only payments for electricity, but also any payments for fuel oil for heating and any other fuels that are typically not provided by a utility.

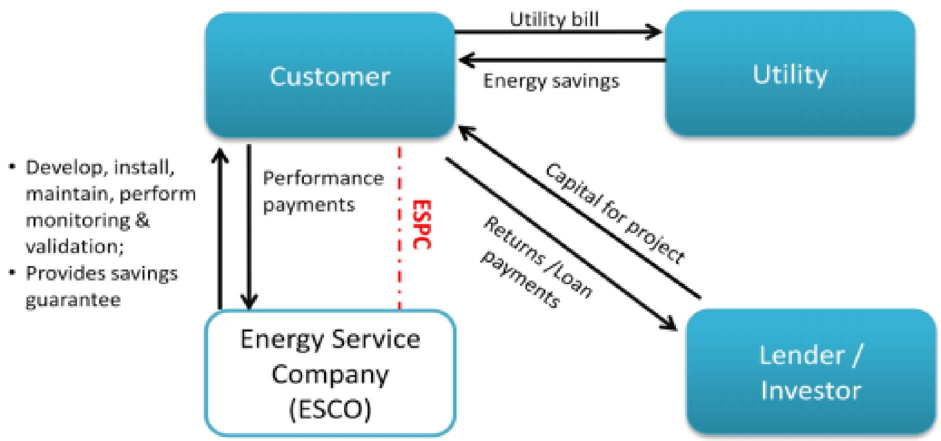



**Figure 7. Basic ESPC Structure**[26]

#### *3.1.1.1 ESPC Issues Specific to Federally Owned Airports*

Some aspects of an ESPC are specific to federally owned airports. Most importantly, a federally owned airport undertaking an ESPC is able to upgrade much of the energy-related infrastructure without the need for upfront capital funds.[27] In addition, for Federal facilities looking to decrease energy use and carbon emissions, the U.S. Department of Energy (DOE) sponsors a program called the Federal Energy Management Program (FEMP). FEMP provides a list of qualified ESCs that must be used for Federal ESPCs,[28] but this list can also be used at least as a starting point for locating ESCs for non-Federal facilities. In a Federal DOE FEMP arrangement, the sole interface for the airport facility is the ESC itself, including any financing needs for the project.

### 3.1.2 Energy Services Agreements and Managed Energy Services Agreements

The ESA model (also known as a "shared-savings agreement") is similar to the ESPC model with some key differences with respect to ownership and incentives. It draws its inspiration from the power purchase agreement (PPA) structure commonly used for energy generation projects. In the ESA and MESA models, a project developer, on behalf of the customer (airport), arranges for the installation of energy efficiency measures by an ESC and coordinates the capital investment in the project.

Typically, the project developer establishes a "special purpose entity" (SPE) for the project and investors provide capital for the energy efficiency project through investments in the SPE. The SPE then owns the energy efficiency equipment and all rebates, tax incentives, or other government incentives during the term of the ESA, while the airport pays for the energy saved as a service. Unlike the ESPC, the airport's payments are based on a percentage of the actual energy savings achieved, either as a percentage of the airport's utility rate or as a fixed dollar amount per kWh saved. This differs from the ESPC model where a set payment is established at the

[26] Source: https://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf

[27] By law, the ESPC carried out at a Federal facility must take on the financing of the energy savings measures. This is not often the case for other publicly owned airports.

[28] http://energy.gov/eere/downloads/department-energy-qualified-list-energy-service-companies

beginning of the project and it will not change no matter how great the energy savings. The airport would usually have an option to purchase the energy saving systems at the end of the contract term for their current fair market value.

Figure 8 illustrates the structure of the ESA. The main difference between the ESPC and the ESA is that within an ESA, the project developer (via the SPE) is responsible for owning and financing the project, as can be seen by the arrows between the SPE and the financing institution.

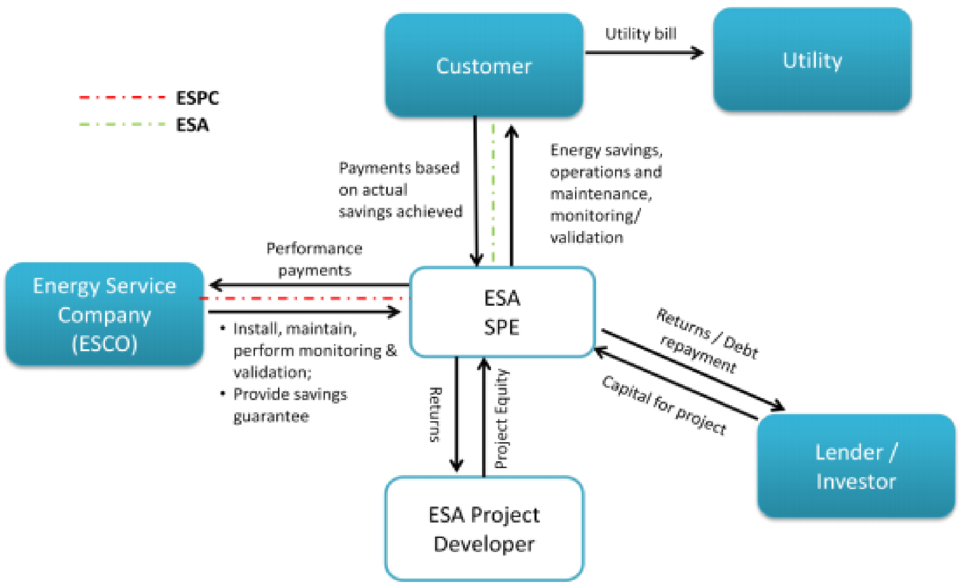



**Figure 8. Basic ESA Structure**[29]

A MESA is very similar to an ESA—the essential difference is that the project developer plays an additional role, serving as an intermediary between the customer (airport) and the utility companies/energy providers. Within a MESA structure, the airport makes a single payment to the project developer for all of its energy expenses. In contrast, under an ESA structure, the airport pays the ESA provider for the realized savings and then pays each of its utilities/energy providers individually for the water, gas, electricity, or other energy usage. Figure 9 illustrates the responsibilities of a MESA contracting structure.

Similar to the ESPC model, the project developer and/or ESC for an ESA/MESA may provide a performance guarantee. However, because the airport's payments are based on the actual amount of realized energy savings and may change over time, there is an incentive for the project developer and ESC to achieve savings that exceed the guaranteed level. This incentive does not exist for an ESC in an ESPC. As a result, the ESA/MESA model may encourage the use of newer, more innovative technology. An ESPC, in contrast, tends to focus on more conservative, proven technologies. Even though older technologies might not realize the most efficiency gains, they have a longer history of performance data and the ESC considers them less risky.

[29] Source: https://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf

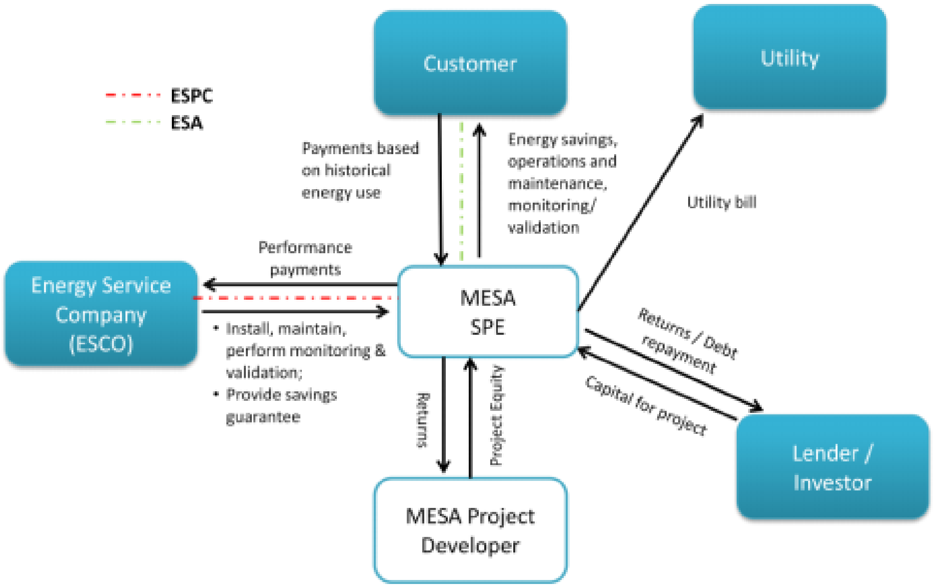



**Figure 9. Basic MESA Structure**[30]

The differences between the ESPC, ESA, and MESA contracting models that have been discussed in this chapter are summarized in Table 2.

**Table 2. Key Characteristics of Three Contracting Mechanisms for Energy Efficiency Improvements**[31]

| | ESPC | ESA | MESA |
|---|---|---|---|
| **Ownership** | Airport owns all improvements throughout the term. | Project developer owns improvements during the term. Airport may purchase them when the term ends. | Project developer owns improvements during the term. Airport may purchase them when the term ends. |
| **Funding upfront costs** | Airport uses debt or loan financing if needed. | Project developer is responsible for arranging 100 percent of the capital. | Project developer is responsible for arranging 100 percent of the capital. |
| **Market penetration in public/nonprofit sector** | High | Low | Low |
| **Typical project size** | Unlimited, but transaction cost may be too high for very small projects | $250,000 to $10 million | $250,000 to $10 million |
| **Responsibility for utility bills** | Airport or ESC | Airport | MESA provider |
| **Responsibility for operations and maintenance (O&M)** | ESC (usually; can be specified in contract) | Project developer/ESC | Project developer/ESC |

[30] Source: https://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf

[31] Source: https://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf

| | ESPC | ESA | MESA |
|---|---|---|---|
| **Guarantee of energy savings at a certain level?** | Yes | Usually; can be specified in contract | Usually; can be specified in contract |
| **Provider conducts baseline measurement of energy use and ongoing measurement and verification (M&V)** | Yes | Yes | Yes |
| **Guaranteed maximum fixed price?** | Yes | No, price is on a relative basis rather than fixed (i.e., price per unit of energy saved or per dollars in energy savings) | No, price is on a relative basis rather than fixed (i.e., price per unit of energy saved or per dollars in energy savings) |

### 3.1.3 Pros and Cons of Using an Energy Services Contract

Common advantages for ESPCs, MESAs, and ESAs include a simplified project development process, guaranteed performance and net positive cash flow, the ability to implement improvements with little to no upfront costs, and the ability to capitalize on the deep experience of ESCs. All contract mechanisms also typically provide the customer with ongoing M&V services, as well as equipment operations, maintenance, and repair services.

There are also a few common challenges associated with energy services contracts. ESPCs, MESAs, and ESAs all rely on an assessment of baseline energy use, which can be difficult to derive in the face of incomplete data. It can also be difficult to identify the sources of subsequent changes in energy consumption. Aside from any improvements installed as part of the contract, a range of other factors will also influence energy use, such as fluctuating occupancy rates or behavior. The airport and service provider would need to discuss and agree upon a methodology for estimating the impacts of installed improvements, acknowledging and accounting for other variables. Aside from these general advantages and disadvantages, Table 3 shows advantages and disadvantages that are unique to particular contracting mechanisms.

**Table 3. Advantages and Disadvantages of Different Energy Efficiency Contracting Mechanisms**[32]

| | Advantages | Disadvantages |
|---|---|---|
| **ESPC** | • Model is commonly used and familiar to government organizations and ESCs.<br>• Fixed-price contract reduces price risk.<br>• Contractor brings technical and financial expertise to the project. | • Airport may need to identify financing for some initial capital costs.<br>• ESCs tend to be conservative to manage risk (avoiding innovative and potentially more effective technologies). This is because there is little incentive for the ESC to achieve efficiency gains in excess of the guaranteed savings.<br>• High transaction costs<br>• Long negotiation periods |
| **ESA** | • Airport need not pay any upfront capital costs.<br>• Airport pays only for actual savings realized.<br>• Airport can pass through to its tenants an applicable share of the energy payments (as tenants will also gain from efficiency improvements).<br>• Encourages the ESC or project developer to minimize the capital investment required and maximize the energy savings achieved, even beyond the savings guaranteed to the airport.<br>• ESA provider may be able to obtain financing for groups of similar energy efficiency projects that meet certain criteria from a single investor, lowering transaction costs<br>• Third-party ownership of the equipment means that the incentives, particularly the tax incentives, can belong to an entity that can make the most use out of them. | • Project developer has to secure debt and/or equity financing from providers that understand the ESA model, which is currently less common than the ESPC model; widespread familiarity with the well-established PPA model may help mitigate this weakness. |
| **MESA** | • Same as ESA, above, with one additional advantage: the airport has a single point of contact and a single payment for all utility/energy expenses. | • Same as ESA, above, with one additional consideration: the MESA project developer may have a slightly smaller pool of potential investors, since investors would need to be willing to assume the risk of escalating utility rates (in the MESA, the project developer directly pays the utility bills). This is not a direct disadvantage for the airport, as long as the project developer can ultimately identify financing. |

While ESPCs, MESAs, and ESAs differ from each another, they offer the airport an opportunity to realize substantial energy savings with little risk and, in some cases, with no upfront capital. Because of this, the energy services contract is a valuable tool in the carbon neutral airport process.

[32] Source: https://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf

Once the publicly owned airport has reviewed its state requirements for entering into an energy services contract and determined the best contracting mechanism for the airport, the solicitation process begins.

## 3.2 Solicit Proposals for the Energy Services Contract

The airport is responsible for issuing either a request for proposals (RFP), request for qualifications (RFQ), or request of interest (ROI) to the public seeking a service provider's response for an energy services contract.[33] In the first case, a formal RFP is prepared. An RFP is usually the more demanding task for the responding company as it essentially includes all information within the RFQ as well as a detailed proposal that is specific to the airport facility. An RFP is submitted early in the procurement process to inform suppliers that the airport is looking to procure energy services in support of carbon neutrality. The RFP alerts suppliers that the selection process is competitive, allows for wide distribution and response, and ensures that suppliers respond factually to the airport's requirements. An airport facility will receive much more relevant information from responses to an RFP, but at the possible cost of fewer (or no) responses. Writing a good RFP takes time and effort and a well-written RFP will bring in better-defined proposals. Appendix G is a guide to developing an RFP for renewable energy with links to existing airport RFPs.

In the second case, an RFQ is submitted to gather vendor information from multiple companies to generate a pool of prospects. An RFQ response involves detailing how qualified the company is for the project based on past work, expertise, years of experience, etc. This eases the RFP review process by narrowing the field of candidate energy service vendors to only those that meet the airport's list of qualifications. Alternatively, the RFQ can be used as the sole selection process in which case qualified candidates may be interviewed. There are pros and cons associated with each solicitation method, which are further discussed in Appendix D.

An RFP/RFQ solicitation typically includes:

- Description of services to be procured;
- Referenced regulations and requirements;
- Potential ECMs;
- Facility data (building size, use, occupancy, etc.);
- Energy consumption data for each utility with consumption rate by building if available;
- Purpose and goals of the ESC contract (including carbon neutrality if this is the goal);
- Evaluation criteria; and
- Method for comparing responses.

Once the solicitation is issued and responses are received by the airport, contractor selection is next.

## 3.3 Evaluate Proposals and Select a Contractor

Selecting a contractor from the submitted proposals is a critical step in the carbon neutral airport program. An

[33] An ROI is specific to the FEMP ESPC for Federal facilities.

airport will need to work closely with the energy services contractor throughout the project; they will make many joint decisions. Thus, the airport needs to carefully evaluate the submitted proposals to ensure the best contractor is selected.

Upon receiving the RFPs/RFQs responses, the airport facility (and any other required parties dictated by state regulation) review the proposals and select one based on the stated evaluation criteria. Regardless of whether an RFQ or RFP is used, a selection committee including airport representatives and any other project partners should be used in the final selection. A selection panel as large and diverse as is practical is recommended to yield the best selection. The award is made to the provider with the lowest cost that also possesses the skill and capability to perform the work.

An airport can use a number of tools for the proposal selection process. One simple and useful tool for gathering input, analyzing differences, and selecting the best contractor is known as the Analytical Hierarchy Process[34] (AHP), which can be used for any decision over the course of the project. AHP is a widely used, structured technique for organizing and analyzing complex decisions, often by a group. While many different decisionmaking processes rely on AHP as a foundation, a six-step process is offered below:

1. Create a list of project requirements that are separated into project musts and project wants. Document assumptions made when making the list or deciding between a must and a want.
2. Use a spreadsheet to perform pairwise comparisons among the wants. Ask the team if a given want is more important, of the same importance, or is less important than others.
3. Record the result in the spreadsheet that is capable of calculating relative weights for those wants. See Figure 10 for an example of a pairwise comparison.
4. Gather a list of the alternative possibilities, such as a list of candidate ESCs. Eliminate any alternatives that do not meet the list of project musts from step 1.
5. For the wants identified in step 1 and used in step 2, create an agreed-upon list of quantitative grades for each want. Typically, a range from 1 to 3 is used, but any scale is acceptable.
6. Using the weights from steps 2 and 3, the remaining alternatives from step 4, and the grading scale from step 5, evaluate all alternatives by assigning a grade for each want on a scale from 1 to 3 and then multiplying this grade by the weight. The overall sum of this weighted grade for each want is the overall score for that alternative.

[34] https://en.wikipedia.org/wiki/Analytic_hierarchy_process

**Is the (purple column criteria) more important than the (orange row criteria)?**
**1.0** = purple criteria more important
**0.5** = equal importance
**0.0** = orange criteria more important

Cells will color themselves to indicate the more important text

| | Strong Program Understanding | Compelling Airport Vision and Commitment to Progam | Demonstrated Stewardship Leadership | Knowledge Transfer Expertise and Experience | Dedication to High Efficiency & High Potential for Energy Generation | Effective Proposal Document | Provided Key Data |
|---|---|---|---|---|---|---|---|
| **Compelling Airport Vision and Commitment to Carbon Neutral Airport Program** | 0.0 | | | | | | |
| **Demonstrated Stewardship Leadership** | 0.5 | 1.0 | | | | | |
| **Knowledge Transfer Expertise and Experience** | 1.0 | 1.0 | 0.0 | | | | |
| **Dedication to High Efficiency and High Potential for Energy Generation** | 1.0 | 0.0 | 0.0 | 0.0 | | | |
| **Effective Proposal Document** | 0.0 | 1.0 | 0.5 | 0.5 | 1.0 | | |
| **Provided Key Data** | 1.0 | 1.0 | 0.0 | 0.0 | 0.5 | 0.0 | |
| **CALCULATED WEIGHTS** | 3.5 | 5.0 | 1.0 | 1.5 | 4.5 | 2.0 | 3.5 |
| **WEIGHT PERCENTAGES** | **17%** | **24%** | **5%** | **7%** | **21%** | **10%** | **17%** |

**Figure 10. Example of a Pairwise Comparison Matrix Used in Step 2 of the AHP**

Figure 10 illustrates step 2 of the AHP, in this case for selection of an airport to participate in a carbon neutral program. The purple column is compared to each orange row, one-by-one. If the purple column is more important to the project, a 1 is entered. If the column and row are of equal importance, a 0.5 is entered. If the column is less important than the row, a 0 is entered. The calculated weights are then the sum of the column values plus the sum of 1 minus each of the row values not represented in the column. For example, the weight of 1.5 for Knowledge Transfer Expertise and Experience is the column sum (0.0+0.5+0.0) plus the sum of 1 minus each of the row values (1-1.0)+(1-1.0)+(1-0.0). The results are then easily converted to percentage weights if desired. In the next step in the AHP process, total scores are calculated for the energy services contractor proposals. The goal of the AHP is to use a tool to navigate the airport team through an assessment process that recommends the best selection after completing the six steps. Appendix F provides a more detailed description of the AHP process.

Using the process described above, or an alternative mechanism if the airport prefers, an energy services contractor is selected. Following contractor selection, the airport will need to put a contract in place using the guidelines provided by the state (if the airport is publicly owned), the Federal government (if the airport if federally owned), or as described in company policy (if the airport is privately owned). As mentioned earlier, Appendix B summarizes state-level regulations on ESC contracts.

# 4 Pursue Energy Conservation Measures

Up until this point in the process, airport staff members have conducted most of the work for the carbon neutral airport project. The airport has determined what scopes to include in the project; evaluated existing financial or contractual obligations or constraints that could limit renewable energy and/or the establishment of an ESC contract; developed and issued an RFP for the ESC contract; reviewed responses to the RFP; and selected an ESC.

Going forward, the ESC is responsible for implementing ECMs. The main role of the airport is now to ensure that detailed and frequent communication occurs between the ESC, the airport, and any other entities that have jurisdiction to secure financing for the project. Should the airport wish to take on efforts to reduce electricity consumption from plug loads—which are not addressed by the ESC—this would also be their responsibility. In this section, we discuss the work that the ESC will conduct and critical airport involvement in the process. Figure 11 shows an overview of the process.

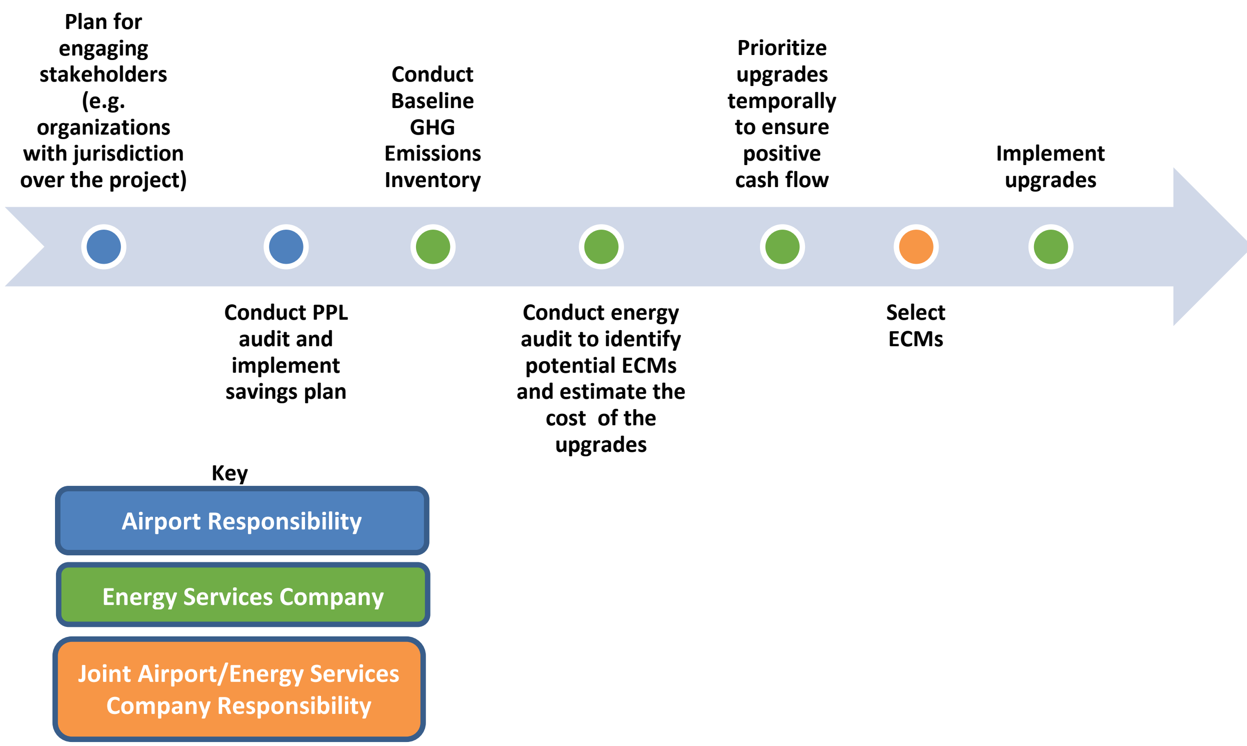



**Figure 11. ESC-led Process to Implement ECMs**

## 4.1 Communications between Airport Officials and ESC

Once the energy services contract is in place, effective and frequent communication between the ESC and airport staff responsible for the carbon neutral airport project is critical to project success. Thus, periodic meetings between the ESC and airport officials should be established. Participation by any additional agencies that have jurisdiction should also be encouraged (e.g., city finance committee, state department of revenue, historic preservation). First, a list of all agencies or other organizations that have jurisdiction over the project should be developed and a plan for engaging those entities should be put in place. Coordination meetings should be held weekly at first and once the project planning is complete can meet less often.

During the project meetings, the following types of information should be reviewed and agreed to by the airport and any additional entities or agencies with jurisdiction:

- Cost burden for the investment grade audit (discussed below);
- Description of specific ECMs;
- Cost and net present value for each measure;
- Proposed hierarchy for introducing ECMs;
- Renewable energy options (technologies, size of system);
- Limitations on renewable energy use (contractual, glare, local opposition, endangered species, other);
- Renewable energy target (kW) and specific types proposed;
- Financing and ownership options and risks associated with each;[35] and
- Selection of financing mechanisms and terms for financing.

## 4.2 Baseline GHG Emissions Inventory

This report assumes that the airport will rely on an ESC to develop a GHG baseline inventory. However, if the airport chooses to conduct an emissions inventory on its own, a number of free tools are available to airport staff to develop the baseline GHG emissions inventory. Typically, most of the Scope 1 and 2 emissions inputs are available from airport fuel, utility, and other records, with the notable exception of construction emissions.

The Airport Council International Airport Carbon and Emissions Reporting Tool (Version 3.0) tool (ACERT)[36] and the U.S. DOE FEMP GHG calculator tool are two publicly available, free Excel spreadsheet tools that can be used to develop an airport GHG inventory.[37] Both tools contain emission factors for all Scope 1 and 2 sources, and the ACERT tool also allows estimation of aircraft and other tenant activity.[38] The tools automatically calculate carbon dioxide ($CO_2$) emissions and carbon dioxide equivalent ($CO_{2e}$) emissions for methane ($CH_4$),

[35] For example, if renewable energy certificate funds are used to offset the capital cost of solar panels, what impact would changes in certificate prices have on the payback for the panels.
[36] www.aci.aero/About-ACI/Priorities/Environment/ACERT
[37] www.fedcenter.gov/programs/greenhouse/inventoryreporting/fempceqresources/portal/
[38] Should an airport wish to estimate aircraft emissions, as available from the Aviation Environmental Design Tool. www.faa.gov/about/office_org/headquarters_offices/apl/research/models/aedt/

nitrous oxides ($N_2O$), and hydrofluorocarbons (HFC) based on inputs such as energy consumption or refrigerant usage. Although the format of the FEMP calculator is different than other calculators, the underlying method for calculating emissions is based on the same protocol—the WRI and World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol.[39]

The following sections describe the steps in determining ECMs.

## 4.3 Energy Audit and ECM Lifecycle Cost Analysis

The first step in ESC work is to establish airport baseline GHG emissions and fuel consumption (even if the airport has already done so); identify potential energy saving measures; and estimate the cost for making the recommended energy upgrades. This work is undertaken as part of the energy audit process.

### 4.3.1 Background

An energy audit is an inspection, survey, and analysis of energy flows for energy conservation in a building. The energy audit allows an energy services contractor to select the most cost-effective approaches to reducing building energy consumption. There are four levels of energy audits: Benchmarking, Level I, Level II, and Level III. In the Benchmarking phase, utility bills and other energy information are gathered and the performance of the building is compared to other buildings of similar type. Level I is a walkthrough audit where simple, low-cost improvements are identified and a potential list of ECMs is developed to inform future, more detailed audits. This inspection is based on a visual assessment of heating ventilation and air conditioning (HVAC) equipment, lighting, and other applications in the building as well as an evaluation of operating data and recorded energy consumption. Level II is a detailed energy audit that includes a breakdown of energy use for specific building systems. This level can include on-site measurements and computer-based simulation to evaluate energy retrofits. In Level III, also called an investment-grade audit, a detailed analysis of capital intensive modifications is conducted, involving a rigorous engineering study.

### 4.3.2 Level I Audit

As part of the response to the airport's RFP for an ESC, respondents will typically conduct a Level I audit and include information in the proposal on suggested ECMs such as switching lighting from compact fluorescent light (CFL) to light emitting diode (LED), improving building insulation, upgrading the HVAC system, and/or other measures.

### 4.3.3 Benchmarking

Benchmarking typically is the first type of audit conducted by an ESC once it is under contract. The benchmarking effort includes gathering information on the annual volume of fuel used to support airport

[39] www.ghgprotocol.org/

operations, including gasoline, diesel, natural gas, and propane jet fuel used for airport operations such as fire training and electricity bills for the most recent year. Costs for purchasing this energy are typically gathered at this point as well. The airport is responsible for providing the contractor all records on fuel use and costs. The benchmarking exercise establishes the total GHG emissions associated with annual airport-related activity. In addition, the audit segments the GHG emissions by source, and assigns a cost for different types of energy used by the airport. The benchmarking audit provides the baseline emissions and fuel consumption inventory for the project, which establishes the amount of energy that needs to be reduced in order to reach carbon neutrality.

Establishing an accurate baseline is an important aspect of the project since the estimate of monetary savings realized from the implementation of energy saving measures is based on the estimate of baseline energy costs. If the baseline energy usage is overstated in the benchmarking exercise, then savings could also be overstated. In an energy services contract, the savings from the program will be guaranteed, so getting the baseline right is the responsibility of the energy services company. If the airport is forgoing the energy services contract, then they will need to be careful to estimate energy usage correctly.

### 4.3.4 Level III Audit: Process and Results

After the initial benchmarking audit is conducted to establish baseline GHG emissions and fuel consumption, a more detailed Level III or investment grade audit is required. A fee is associated with this audit that the contractor typically rolls into the overall project cost. However, there may be instances where the airport is required to pay for the investment grade audit. Take, for example, a case where an airport selects an energy services company which then conducts a Level III audit, but the airport does not subsequently implement ECMs. In this case, the airport could be responsible for paying for the audit, which can cost upwards of $40,000. If the contract terminates through no fault of the ESC, the airport would be responsible for the cost of the investment grade audit, but the airport would retain ownership of all data and reports completed to date.

The Level III audit includes a detailed analysis of all lighting, HVAC systems, and airport vehicles. As part of the audit, estimates of the energy savings and costs for replacing or upgrading inefficient or outdated HVAC equipment such as boilers, furnaces, chillers, heat pumps, and ventilation system components are developed. In addition, a complete inventory of different types of lighting technology and wattage throughout the airport is developed and a cost for replacement is prepared. Infrared or other analysis is conducted to determine where additional insulation is needed in airport buildings. An analysis of building systems is also done to determine if software upgrades are needed. A comparison of the preliminary audit and investment grade audit is provided in Table 4.

**Table 4. Preliminary Audit Compared to an Investment Grade Audit**

| | Preliminary Audit (PA) | Investment Grade Audit (IGA) |
|---|---|---|
| **Initial analysis** | Cursory (BTU/sq. ft.; utility bill and rate review; “rule of thumb”) | Detailed (understanding system operation, interdependence and baseline conditions) |
| **Inspections** | Short, visual | Detailed, room by room |
| **Discussions with O&M staff** | Brief | Thorough |
| **Economics** | Rough order of magnitude to determine project viability | Detailed |
| **Measurement** | None | Installed meters |
| **Design** | None | Full engineering design |
| **Contractor pricing** | None | Detailed bidding |
| **Modeling** | None | Computer building models |
| **Report** | Preliminary list of ECMs that are probably viable based on cursory analysis | Finalized list of ECMs, M&V plan, detailed project costs (soft and construction) |

#### *4.3.4.1 Results of Level III Audit*

The Level III audit will result in a suite of potential energy saving measures—potentially dozens of different measures. Each measure should indicate the capital cost, annual energy savings, annual cost savings, financing costs, and years to pay back. The ESC will calculate the lifecycle cost for each measure as part of the Level III audit. Table 5 provides a summary example of such an analysis. Each of the measures shown in the table has a different payback period, with some of the measures paying back very quickly and others taking ten years or more. Appendix E provides a more detailed example of a lifecycle cost analysis.

The energy services company will recommend implementing the energy saving measures in a sequence that provides a positive cash flow for the package of measures, even if some of them have long payback times. In this way, the more costly measures can be financed by the measures that have the quickest return on investment.

**Table 5. Sample Results of Lifecycle Cost Analysis for Potential ECMs**

| Energy Saving Measure | Initial Cost | Annual savings | Source of Annual Savings | Years to payback | Net present value (20 years) | Assumptions |
|---|---|---|---|---|---|---|
| **Efficient lighting** | $50,000 | $25,000 | 10 MW electricity savings, labor savings of $1,000 | 2 years | $305,310 | Cost of electricity and liquid fuels increases at 3% per year. Interest rate of 3%. Rebates for measures included. |
| **Building wall and ceiling insulation** | $50,000 | $5,000 | 600 gallons #2 fuel oil reduction, 3,000 ft3 natural gas, 26 MW electricity | 10 years | $21,062 | |
| **Window and door sealing** | $40,000 | $4,000 | 500 gallons of #2 fuel oil, 2,000 ft3 natural gas, 24 MW electricity | 10 years | $16,849 | |
| **Efficient furnaces** | $60,000 | $40,000 in year one, $6,000 every year after | $40,000 rebate, 1,500 gallons of #2 fuel oil | 3.5 years | $65,274 | |

Bundling ECMs with short and long payback times allows the overall project budget to remain net positive over the entire life of the contract. An upcoming report from TRB *Developing the Airport Business Case for Renewable Energy* will provide information on making the business case for renewable energy at airports.[40] A net present value calculation is also needed for renewables since these are included in the ECMs.

In addition to determining how to bundle energy saving measures to ensure a positive cash flow in each year, the results of the Level III audit will provide a roadmap for carbon neutrality. An example is provided in Figure 12. The figure shows the eight approaches chosen to reach carbon neutrality for a hypothetical airport. In this example, six energy saving measures provide a total of 35 percent energy savings. The measures are listed in order of their effectiveness. In this example, replacing T5 CFLs and CFLs with LED are undertaken first since they are the most cost effective and reduce 17 percent of facility energy consumption. Adding building insulation is listed next, with a potential energy savings of 6 percent resulting from lower No. 2 fuel oil and natural gas use in the winter and less electricity consumption in summer for air conditioning. When all of the energy saving measures are implemented, the Level III audit estimates that 35 percent of the airport's energy consumption will be reduced. The remaining 65 percent of energy consumption is proposed to be reduced through installation of renewable energy on-site. This is detailed in Section 5.

[40] See: http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3702

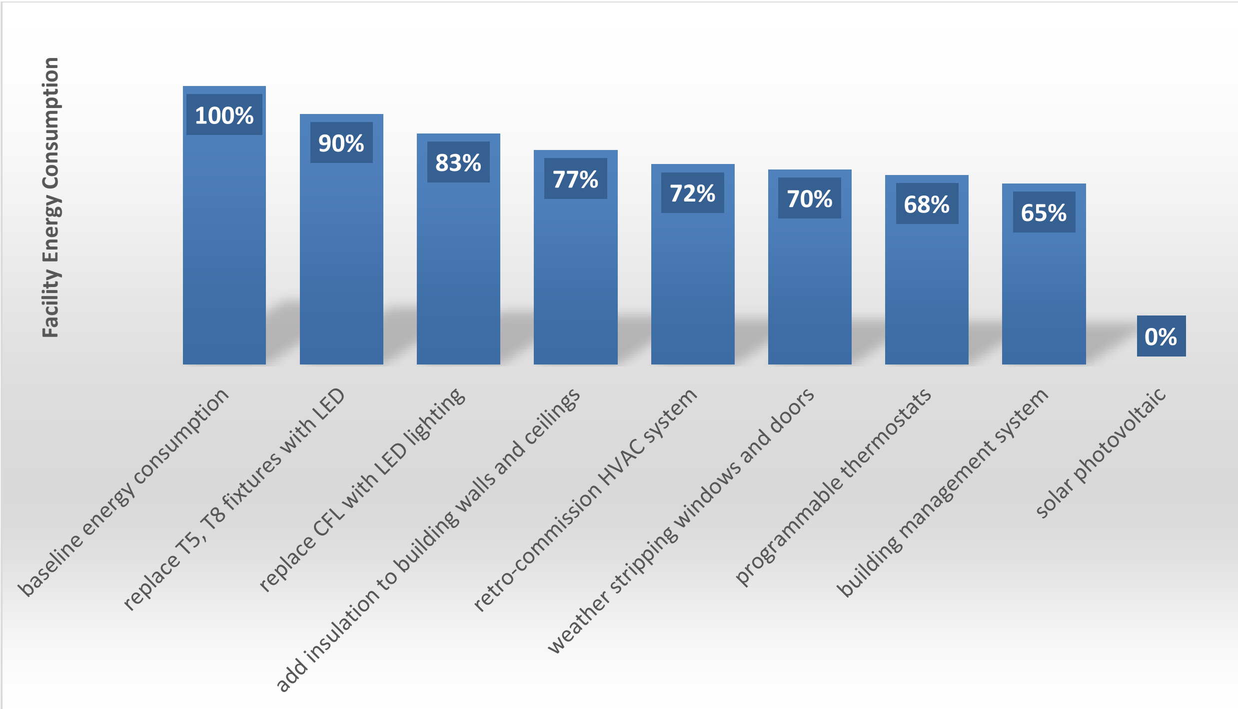



**Figure 12. Example Level III Audit Energy Saving Measure Recommendations**

The airport and the ESC will work together to select ECMs. For example, if the ESC recommends insulating a maintenance shop for airport vehicles but the airport plans to replace the building in the near future, upgrading at this stage would not make sense. A back and forth discussion on the merits of each measure is needed as part of the process of selection.

#### *4.3.4.2 Plug and Process Audit*

Plug and process loads (PPLs), also known as plug loads or parasitic loads, describe the energy load resulting from electrical devices that are not related to general lighting, heating, ventilation, cooling, and water heating in a building. Common examples of PPLs include computers, displays, task lighting, kitchen appliances, laundry machines, elevators, escalators, and conveyor belts.

Reducing PPL-related energy consumption can be an important way to reduce overall energy consumption. PPLs can account for up to 33 percent of U.S. commercial building electricity consumption, but minimizing these loads is a significant challenge in the design and operation of an energy-efficient building. PPLs are diverse, distributed, and cannot be measured simply by reading building utility meters. Quantifying the parasitic electricity consumption of PPLs requires collecting data about how many devices exist in a building, how they are used, and how this usage compares to what people in the building actually require for doing business. Moreover, PPL audit and savings plans are not typically included in energy services contracts with ESCs, since ESCs only address building mechanical and envelope improvements in order to decrease energy consumption. Figure 13 shows the process for evaluating the PPL load in a facility.

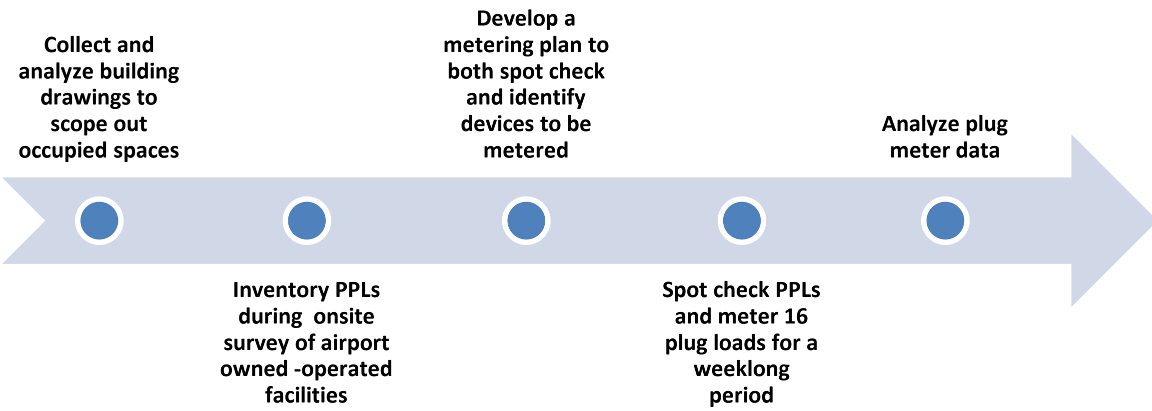



**Figure 13. Workflow for the PPL Audit**

The process requires the airport to install meters on devices such as refrigerators, computers, microwave ovens, and other devices to determine how much energy they use over a week-long period. It also requires that the airport assess how much equipment is needed and if any redundant electronics can be removed or consolidated. Below is a list of example conditions that could be identified and addressed to reduce PPL-related energy consumption:

- Redundant printers in service;
- Lights, desktops, and computer monitors left on at night;
- A lack of standby power or timer-switch implementation on computers and task lights;
- Multiple space heaters in use;
- Summer seasonal equipment running in the winter;
- Charged battery packs left sitting in the charger cradles;
- Coffee warmers continuously on; and
- Use of uninterruptible power supplies.

After identifying the conditions that waste energy, measures can be taken to reduce PPL energy use. Table 6 illustrates some of the approaches to reducing energy consumption from PPLs.

**Table 6. Summary of Sample PPL Energy Reduction Recommendations for Airport Energy Reduction**

| Create a PPL Team | Assemble and Empower a PPL Team to Change Organizational Culture |
|---|---|
| **Implement operational measures** | Disconnect seasonal area airport equipment during off season |
| | Eliminate personal space heaters |
| | Establish policies for thermostat settings |
| | Establish policies to enable "energy saver" mode on devices |
| **Implement cost-effective technology measures** | Install smart power switches: both occupancy- and timer-based |
| | Consolidate and network office equipment for use with multiple workstations |
| | Make a low-energy workstation the airport-wide standard |
| | Investigate low-energy alternatives to energy-intensive equipment |

Implementing these measures could reduce PPL electricity consumption by approximately 50 percent. At one airport, a PPL audit concluded that these changes represented nearly a 10 percent potential savings in electricity.

Once ECMs are identified, optionally including PPL energy reduction, the next step in a carbon neutral airport program is to scope and implement renewable energy facilities on the airport site. Renewable energy generation can offset most or all of the remaining minimized energy needs of the airport, depending on the locally available renewable resources as well as the airport's available land resources and operational layout. The next chapter lays out the steps for assessing on-site renewable potential.

# 5 Assess Potential for On-Site Renewables

Once the ECMs have been selected, as described in the previous section, remaining carbon emissions need to be addressed. There may be potential for on-site renewable energy at an airport. This chapter provides an overview of the process for evaluating the potential for on-site renewable energy production. Three types of renewable energy are evaluated: solar photovoltaic (PV), geothermal, and wind. A recent report from ACRP provides a more detailed discussion of assessing airport renewable energy.[41]

On-site renewable energy may only address a portion of the remaining carbon emissions at the airport. If this is the case, Section 7 discusses the purchase of renewable energy certificates (RECs) and other approaches to reach carbon neutrality.

## 5.1 Considerations

In this report, it is assumed that an ESC will perform the feasibility analysis, permitting, and siting and will provide financing options for renewable energy development. As mentioned earlier, it is possible that an airport will receive bids from ESCs that are unable or unwilling to complete these steps. In this case, the airport may need to pursue renewable energy development separately.

## 5.2 Basic Steps in Renewable Energy Selection

Figure 14 shows the basic steps to establish renewable energy sources at an airport. A more detailed explanation of steps 2-6 is provided in the next sections. For details on the research needed to assess legal, contractual, and natural heritage limitations to the use of renewable energy refer to Chapter 2.

[41] *ACRP Report 141: Renewable Energy as an Airport Revenue Source* (2015). www.trb.org/Main/Blurbs/172634.aspx

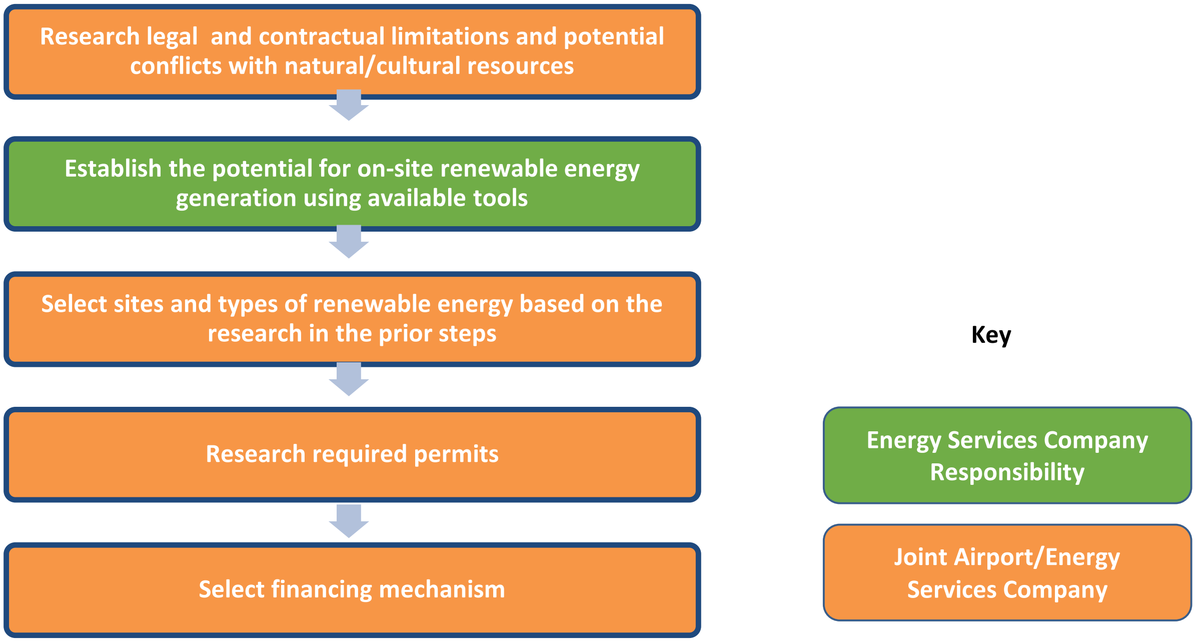



**Figure 14. Process to Establish Renewable Energy Sources at an Airport**

## 5.3 Assess On-Site Renewable Energy Potential

A number of publicly available tools are easy for airports to access and use. These tools give airport staff an initial sense of potential renewable energy resources and take into account the specific geographic location and characteristics of the airport property. These are described in the sections that follow.

The geographic location of an airport largely determines which renewable energy resources are abundant and which are unlikely to serve as energy sources. Although solar energy and wind energy are available everywhere in the U.S., certain regions are sunnier or windier than others. Geothermal heating and cooling systems are viable anywhere in the country, but the feasibility of geothermal systems for electricity generation is highly dependent on geographic location. DOE produces detailed maps and GIS data of renewable energy resource availabilities nationwide,[42] which can be consulted for the airport's specific location. In addition, DOE provides free online tools to estimate the amount of energy that can be generated on a given land area at each geographic location in the United States.

## 5.4 Assess Potential for On-Site Solar Photovoltaic Power

This section describes the steps an airport can take to assess the amount of electricity that can be generated and the cost of installing solar arrays on airport property.

[42] www.nrel.gov/gis/data.html

### 5.4.1 Using the PVWatts Tool

As a rule of thumb for preliminary scoping of a potential solar system on airport property, current technologies yield about 10 watts per square foot, and a solar farm that generates 1 GWh per year requires about 3 acres.[43] Of course, solar energy production per area will depend on the amount of sunshine received in the airport's region while total production will also depend on the available site area for mounting the photovoltaic panels. Generally, only non-aeronautical land may be used, and not all rooftops may be feasible for solar, depending on their structural rating and—if steeply pitched—their aspect (compass orientation). An airport should consult its Airport Layout Plan, inventory available parking lots and roadway areas, and inventory available building rooftops prior to generating a solar production estimate in PVWatts.

PVWatts, a free, publicly available calculator designed to estimate the amount of energy that can be generated from PV energy at any location in the United States (and around the world) was established by DOE, and can be found on the DOE website.[44] PVWatts allows an airport to interactively estimate the generation capacity and financial savings of a solar farm installed on a user-defined parcel of airport land. The user enters the current cost of electricity, draws a polygon on a satellite view of the airport (or enters an array area), and the tool provides an estimate of the performance of this potential PV installation. PVWatts also estimates the cost of energy grid-connected PV energy systems. The calculator uses weather data from the National Solar Radiation Data Base and meteorological data available from the National Renewable Energy Laboratory (NREL). PVWatts software links to Google Earth and allows the user to draw a box over the area they would anticipate using for a solar array. Then, based on the area of the array and the local cost of electricity, it calculates the annual savings and electricity produced.

With PVWatts the airport can readily estimate the potential energy production of hypothetical solar arrays mounted on rooftops, parking lots, and other ground locations. While PVWatts does not produce definitive estimates that account for factors such as shading, it is a powerful screening-level tool to scope solar feasibility. Use the following steps to generate an estimate of energy produced:

1) Enter airport code (e.g., PDX);
2) Select the default weather data for this location;
3) Either enter the system size in kW or select "Draw Your System" to draw a polygon for the first hypothetical solar site;
4) Select "Commercial" under System Type;
5) Enter the airport's current cost of electricity;
6) Keep all other default performance values; and
7) Click "Go to PVWatts results" and record or download the results.

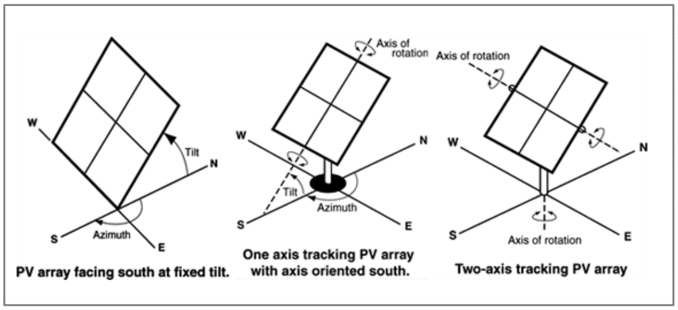
[43] www.energymanagertoday.com/it-takes-2-8-acres-of-land-to-generate-1gwh-of-solar-energy-per-year-says-nrel-094185/

[44] http://pvwatts.nrel.gov/


**Figure 15. Steps for Estimating Potential Solar PV Output from an Airport Parcel Using PVWatts**

By default, PVWatts assumes fixed-tilt solar panels. However, airports that are less area-constrained and have higher available solar energy (e.g., the Southwest) may consider single-axis tilting solar panels that track the sun, as these increase the energy production per panel by approximately 20-30 percent and may be less expensive for a given level of energy production. Tracking systems do require more land area than fixed-tilt systems, as shown in Figure 16. Two-axis tracking systems are also available and provide somewhat higher output per panel than single-axis systems, but these require even more land area and require still higher maintenance, which may not be suitable for most airports.[45]

[45] www.greentechmedia.com/articles/read/Solar-Balance-of-System-To-Track-or-Not-to-Track-Part-I



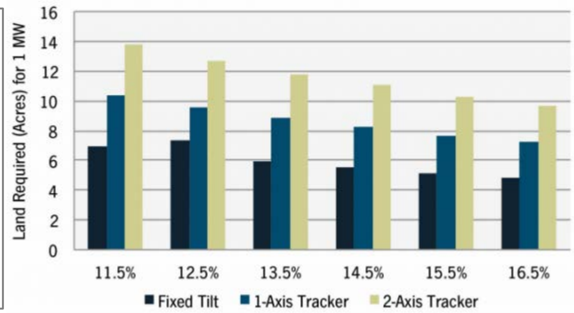




**Figure 16. Left: Fixed Versus Single and Two-Axis Tracking Configurations for PVs; Right: Relative Land Requirements for Each**[46]

### 5.4.2 Long-Term Operation

Regardless of the ownership model but especially if the solar panels are owned by the airport, the degradation and derate factors of the system over time should be considered. Solar panels' energy output decreases approximately 0.5-1 percent per year, which means that if the airport seeks to be carbon neutral and sizes the solar array based on initial output, the airport may fail to remain carbon neutral after a number of years as the solar energy production declines. The airport should confirm the warrantied linear energy output profile over a 20-25 year period from the solar panel manufacturer (see warranty example in Figure 17) and size the array based on future warrantied output to meet the airport's current carbon minimization goals—in other words, oversizing the initial capacity. Additionally, if the airport owns the system, extended warranties for the inverter and other balance-of-system components are highly recommended to reduce financial and maintenance risk.

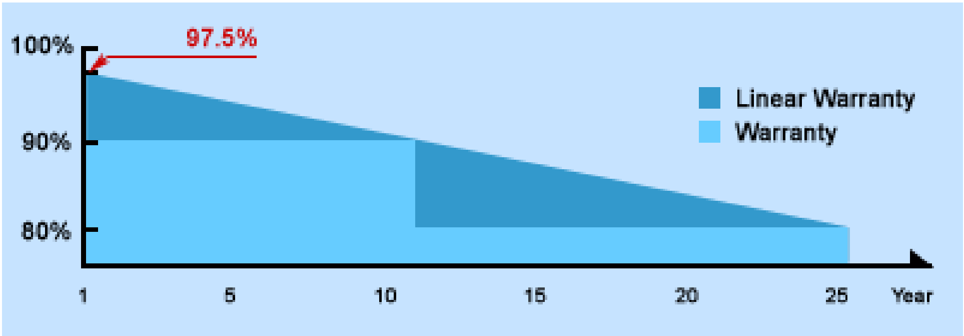



**Figure 17. Industry Standard Solar Panel Performance Warranty Types**[47]

As was shown in the example above, an airport can estimate the amount of electricity that can be generated on different parcels of airport property. This information can be used to estimate how much carbon from airport operations can be eliminated.

[46] http://dqbasmyouzti2.cloudfront.net/assets/content/cache/made/content/images/articles/land-requirements-bos-2013_570_313.png

[47] www.solarmyworld.com.au/cms/wp-content/uploads/2011/07/BYD-Linear-Warranty.gif

## 5.5 Geothermal Resources

A number of airports have used geothermal resources to reduce energy consumption and carbon emissions, either through heating and cooling systems or through electricity generation systems. Geothermal heating and cooling systems require much less planning, engineering, and upfront capital than geothermal energy for electricity production. In addition, for reasons discussed below, geothermal heating and cooling is cost effective at many more sites than electricity production. For these reasons, geothermal resources would most likely be used for thermal heating and cooling at an airport but it is possible that electricity could be produced at an airport from geothermal energy.

### 5.5.1 Thermal Heating and Cooling[48]

Geothermal heating and cooling takes advantage of the constant temperature of the earth to provide heat in the winter and cooling in the summer. Geothermal heating and cooling can be used almost anywhere in the U.S., assuming the availability of sufficient land area. Three components comprise the geothermal system: the ground heat exchanger, the heat pump, and the air handling system. The benefit of such a system is that it helps to protect the owner from price fluctuations. Heating oil and natural gas prices tend to fluctuate. However, the geothermal system would consume some electricity in order to operate. If purchased from a utility, the price of electricity could fluctuate or increase as well, to a certain degree. Geothermal heating and cooling systems pay back within 5 to 10 years and the system life is 50 years for the coil in the earth and 25 years for the inside components.[49]

There are four basic types of geothermal heating and cooling systems: vertical, horizontal, pond/lake, and open loop. Climate, soil conditions, and available land dictate which system is the best for a given property. Horizontal systems require a larger area while vertical systems require much less land but go deeper into the ground. In a vertical system, 4-inch holes are drilled 20 inches apart and 100 to 400 feet into the ground. In a horizontal system, piping is laid in trenches 4-feet deep over a much larger area of land. The size of the system depends on the energy needs of the airport. Diagrams of horizontal and vertical systems are provided in Figure 18.

[48] This section relies on information from NREL: http://www.nrel.gov/learning/re_geo_heat_pumps.html
[49] http://energy.gov/energysaver/geothermal-heat-pumps

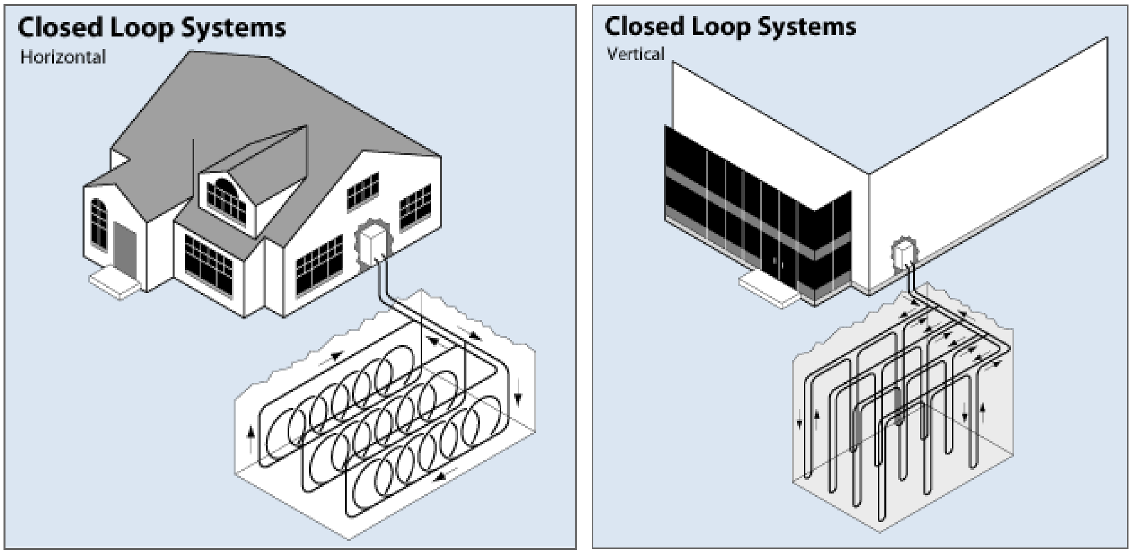



**Figure 18. Diagrams of a (Left) Horizontal Geothermal System and (Right) Vertical Geothermal System[50]**

Two examples of geothermal heating and cooling systems at airports are found at Nashville Airport and Nantucket Memorial Airport. The Nashville International Airport geothermal system relies on the pond design. In this case, a 43-acre lake holding storm water runoff will be used to reduce energy use from the air conditioning system. The $10-million project is projected to save 1.3-million kWh annually and $400,000 per year.[51] The Nantucket Memorial Airport geothermal system draws water from wells that run 180-feet deep beneath the airport terminal. A heat exchanger was installed to remove heat from the water and uses that energy to heat the terminal. The system has enabled the airport to remove two oil-burning furnaces thereby reducing the carbon footprint of the airport's climate-control system.[52]

### 5.5.2 Electricity Production

A major difference between geothermal heating and electricity-producing geothermal systems is the need for a naturally occurring reservoir of hot water in an electricity-producing system. The hot water or steam results from heat and pressure below the surface of the earth.[53] The water or steam must first be located through prospecting and then be accessed through drilling. When tapped as steam or turned to steam, it is then used to rotate turbines that activate a generator, which produces electricity. Geothermal plants have much in common with traditional power plants. The systems use many of the same components including turbines, transformers, and other standard power generating equipment. There are three types of geothermal power plants, with the most common type being a "flash steam" plant.

[50] Source: U.S. DOE

[51] www.hydrogenfuelnews.com/geothermal-system-will-save-nashville-airport-over-400k-a-year/8525180/

[52] www.worldconstructionnetwork.com/news/nantucket_memorial_airport_in_massachusetts_flaunts_a_new_look_090603/

[53] Except in the case of steam which reaches the surface of the earth—such as "Old Faithful" in Yellowstone National Park. There are, however, only two areas in the United States where this occurs and Yellowstone is one of them.

The leveled cost of an electricity-producing geothermal system has been shown in studies to be comparable to natural gas production, but the capital cost is much higher for a geothermal system than for a natural gas or other conventional plant.[54] According to the California Energy Commission, the installation of geothermal systems of 1-10 kW costs up to $3,400 per kW. There are also uncertainties associated with geothermal electricity production and one of those is the difficulty in assessing the temperature of the underground reservoir of water and permeability of the soil and/or rock from the surface. A reservoir of hot water and permeability of the soil are both needed in order to drill wells. To help entities locate sites with good geothermal potential in the U.S., the Geothermal Prospector mapping tool was developed by NREL.[55]

### 5.5.3 Geothermal Prospector

The Geothermal Prospector mapping tool allows the user to identify locations favorable to geothermal energy development. The tool allows users to view a map of nationwide geothermal resources. Users can also download state-specific location information on existing geothermal plants along with plant specifications. Figure 19 provides a color-coded map of the U.S., indicating areas favorable for geothermal power plant location. The red areas represent locations most favorable for geothermal resources. The green represents locations least favorable for geothermal power production. As can be seen from the map, the western states have the greatest potential for geothermal power production.

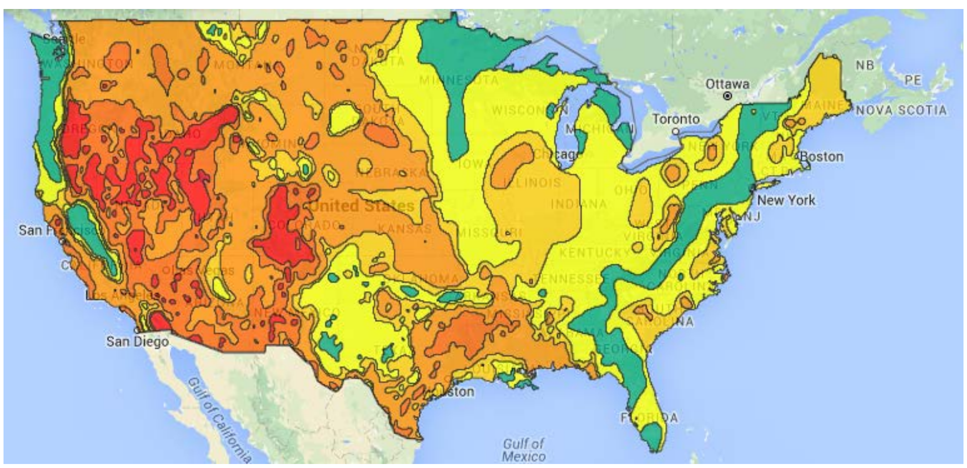



**Figure 19. Map of U.S. Geothermal Resources from the NREL Geothermal Prospector[56]**

### 5.5.4 Decisionmaking Steps for Geothermal Inclusion

Steps required for development of geothermal heating and cooling resources at an airport include the following:

[54] http://geo-energy.org/geo_basics_plant_cost.aspx
[55] www.nrel.gov/gis/tools_gt_prospector.html
[56] https://maps.nrel.gov/geothermal-prospector/#/?aL=nBy5Q_%255Bv%255D%3Dt&bL=groad&cE=0&lR=0&mC=38.16911413556086%2C-87.978515625&zL=4

1) Identify potential land area where the outside components could be installed;
2) Assess the soil conditions of these areas;
3) Determine which type of system (horizontal, vertical, pond, or open loop) should be installed;
4) Determine the size of the system;
5) Evaluate lifecycle costs;
6) Implement the system.

Steps required for development of geothermal electricity production on airport property include:

1) Assess geothermal potential for the geographic site;
2) Determine availability of land area on the site;
3) Assess availability of capital to build the system;
4) Evaluate tax incentives and other financing considerations, such as availability of net metering;
5) Conduct lifecycle cost analysis;
6) Evaluate permitting issues;
7) Determine the design of the system;
8) Implement the system.

# 5.6 Wind Energy

This section describes the steps an airport can take to assess the relative merit and viability of installing wind turbines on airport property, to subsequently plan, install, and operate wind energy generation that reduces or fully offsets the remaining GHG emissions.

## 5.6.1 Assess Wind Resources

As a rule of thumb for preliminary scoping of a potential solar system on airport property, current technologies yield about 1 MW of capacity per 25 acres[57] of land.[58] Wind energy production per area will depend on the amount of wind in the airport's region while total production will depend on the available site area for mounting the wind turbines. Generally, only non-aeronautical land may be used, and not all rooftops may be feasible (for small-scale turbines), depending on their structural rating. An airport should consult its Airport Layout Plan, inventory available land areas, and inventory available building rooftops prior to generating a wind production estimate.

The airport can compare its relative wind resources to other regions at various heights above the ground using DOE wind maps, as shown in Figure 20. These maps are available for heights of 30 meters, 80 meters, 110 meters, and 140 meters above ground level.[59]

[57] Philip G. Gallman, *Green Alternatives and National Energy Strategy: The Facts Behind the Headlines* (2011)
[58] With a typical capacity factor of 0.25, the average output from wind turbine installations is therefore about 1 MW per 100 acres of land, and the energy produced is about 100 MWh per acre per year.
[59] http://apps2.eere.energy.gov/wind/windexchange/windmaps/

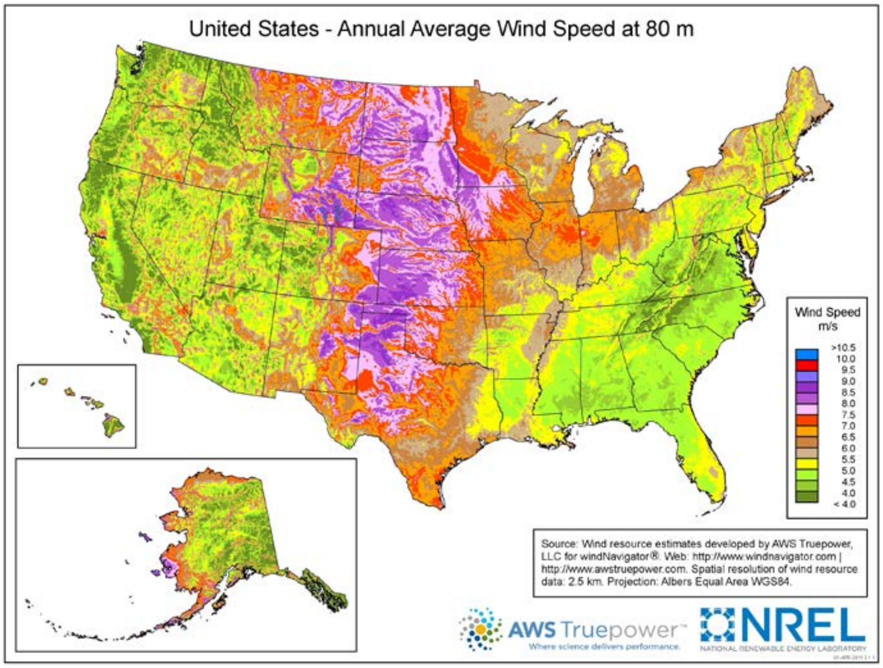



**Figure 20. National Wind Resource Map**[60]

Detailed GIS data can be further referenced for the airport's coordinates and viewed through the Wind Prospector web tool.[61] For example, the wind resources at a height of 80 meters at Denver International Airport (DEN) are displayed in Figure 21. In the figure, "GCF" refers to gross capacity factor—the predicted energy output of a wind turbine at that location divided by the theoretical maximum output produced if the wind turbine were to run continuously at full capacity. The higher the GCF, the greater the expected wind energy production, and the higher the potential for wind energy at an airport site. Typically, the gross capacity factor ranges from 30 to 55 percent,[62] depending on both the wind resource and the type of turbine used.[63]

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[60] www.nrel.gov/gis/images/80m_wind/USwind300dpe4-11.jpg
[61] https://maps.nrel.gov/wind-prospector
[62] www.ownenergy.net/blog/wind-resource-101-jason-lowenstein-phd
[63] Wind Prospector allows the user to assume 2008, current, or near-future wind turbine technology.

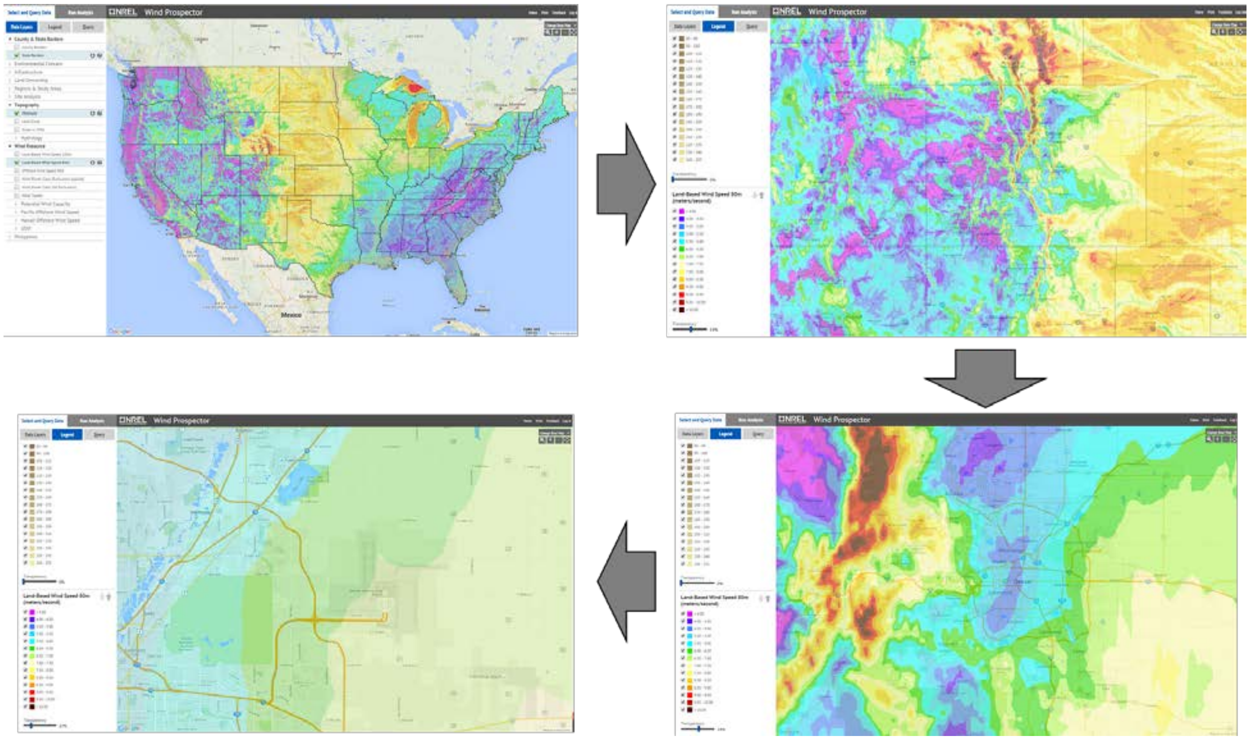


**Figure 21. Wind Prospector Displaying Average Wind Speeds Nationally, for Colorado, and at Denver International Airport (DEN) at 80 Meters; At DEN, Winds Are Strongest in the North and West**

### 5.6.2 Scope Potential Airport Wind Capacity

In contrast to solar arrays, horizontal-axis wind turbines typically require a tower of significant height (hundreds of feet) in order to access higher-speed winds with greater energy potential. A range of wind turbine sizes are shown to scale in Figure 22. Wind turbines must be compatible with the airport's imaginary surfaces, both for safety and for regulatory compliance. Therefore, the placement of wind farms at airports must be carefully considered and scoped.

FAA Regulation Part 77.25 defines a structure of imaginary surfaces in relation to each runway to prevent existing or proposed manmade objects, objects of natural growth, or terrain from extending upward into navigable airspace. The size of each imaginary surface is based on the category of each runway according to the type of instrument approach available or planned for that runway. An object such as a wind turbine becomes an "Obstruction to Air Navigation" if it is of greater height than any imaginary surface. The five imaginary surface types, as defined by FAA, slope out and up from all sides and ends of runways or are a horizontal plane above public use airports. As shown in Figure 23, these include:

- Primary: Aligned with each runway and extends 200 feet from each runway end.
- Approach: Aligned with the runway and extends beyond the primary surface.
- Horizontal: Horizontal plane 150 feet above the established airport elevation.
- Conical: 20:1 slope surface extending beyond the horizontal surface.
- Transitional: Joins approach and horizontal or primary and horizontal surfaces.

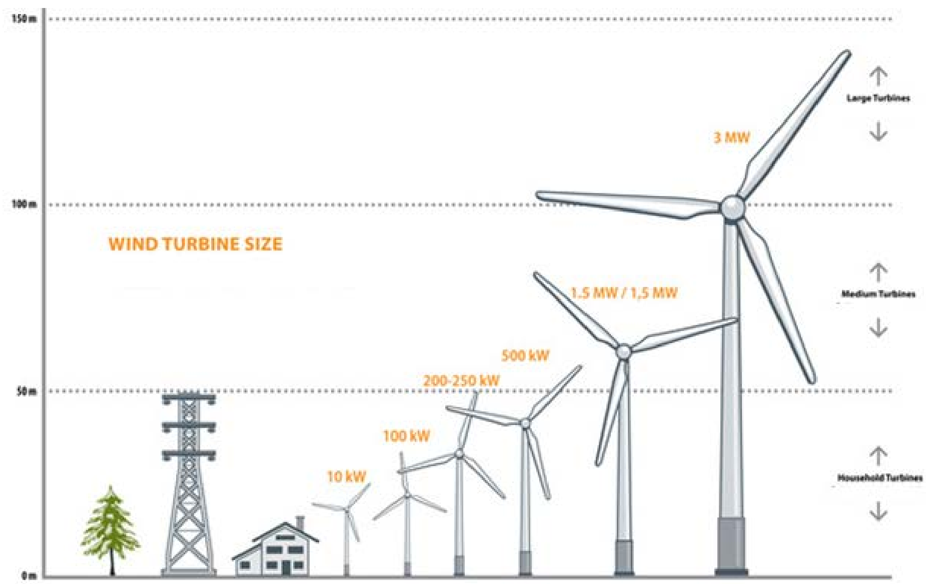
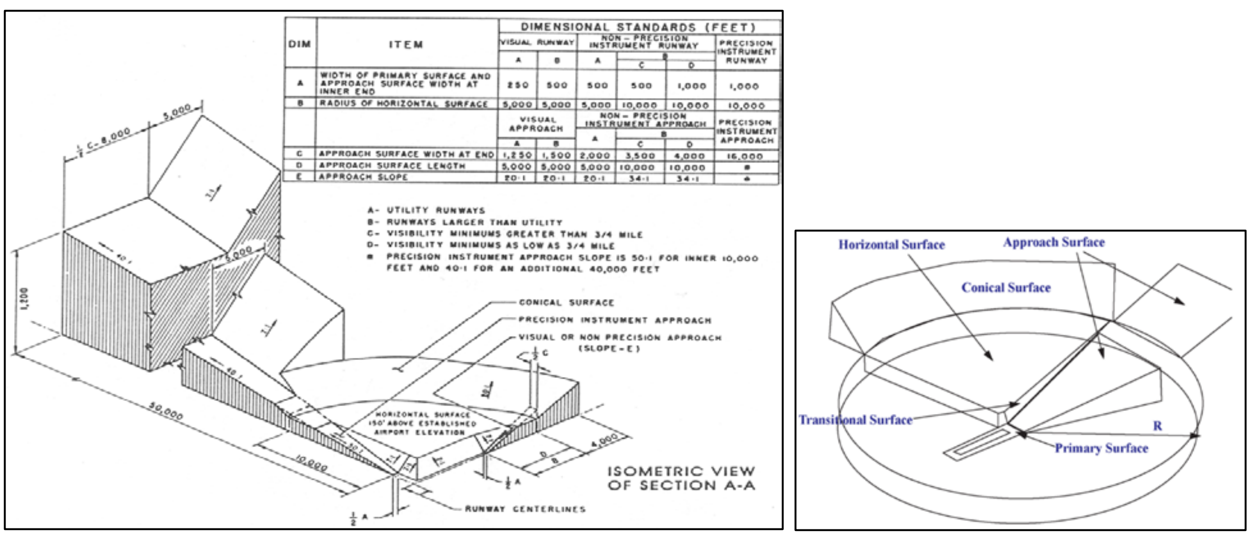



**Figure 22. Wind Turbine Size Categories and Relative Capacities**[64]




| DIM | ITEM | DIMENSIONAL STANDARDS (FEET) | | | | | |
|---|---|---|---|---|---|---|---|
| | | VISUAL RUNWAY | | NON - PRECISION INSTRUMENT RUNWAY | | | PRECISION INSTRUMENT RUNWAY |
| | | A | B | A | B: C | B: D | |
| A | WIDTH OF PRIMARY SURFACE AND APPROACH SURFACE WIDTH AT INNER END | 250 | 500 | 500 | 500 | 1,000 | 1,000 |
| B | RADIUS OF HORIZONTAL SURFACE | 5,000 | 5,000 | 5,000 | 10,000 | 10,000 | 10,000 |
| | | VISUAL APPROACH | | NON - PRECISION INSTRUMENT APPROACH | | | PRECISION INSTRUMENT APPROACH |
| | | A | B | A | B: C | B: D | |
| C | APPROACH SURFACE WIDTH AT END | 1,250 | 1,500 | 2,000 | 3,500 | 4,000 | 16,000 |
| D | APPROACH SURFACE LENGTH | 5,000 | 5,000 | 5,000 | 10,000 | 10,000 | * |
| E | APPROACH SLOPE | 20:1 | 20:1 | 20:1 | 34:1 | 34:1 | * |

**Figure 23. Imaginary Surfaces that Must Not Be Penetrated by Structures Such as Wind Turbines**[65]

In constrained airport environments where medium or large wind turbines are incompatible with these airspace surfaces, small-scale wind turbines of approximately 10 kW capacity may still be installed, as seen on the Boston Logan International Airport (BOS) building roof in Figure 24. Small turbines have longer payback times than large turbines, but they can be publicly visible signals of the airport's commitment to reducing its carbon emissions.

[64] www.energy.techno-science.ca/en/energy101/wind.php

[65] http://www.dot.state.mn.us/aero/planning/documents/zoning/zoningadvisorycommittee6122014/mndot-zoning-workinggroup-slides-61214.pdf

**Figure 24. Small, Residential-Scale Wind Turbines at Boston Logan International Airport**

## 5.7 Permitting Considerations for Renewables

Federal, state, and local permits may be required prior to installing renewable energy generation facilities. The project managers for an airport project would need to check for applicable requirements at all three levels. Section 2.2.2 on page 7 of this report discusses conflicts with protected resources and associated permits that may be required for any project type. The sections that follow describe permitting considerations specific to solar, wind, and geothermal installations. Since there are many jurisdictions in the U.S. with their own specific requirements (500 jurisdictions in California alone), this section merely provides an overview with links to resources for airports.

### 5.7.1 Solar

Prior to installing a solar array, an airport would need to submit a "Notice of Proposed Construction or Alteration" form (FAA Form 7460-1). If there is potential for solar glare, FAA requires that the airport use the Solar Glare Hazard Analysis Tool to determine the potential impact from observed glare. Solar glare is a hazard that can affect both pilots and air traffic controllers. The tool, which is available at https://share.sandia.gov/phlux, allows the user to model the result of modifications to variables (e.g., tilt, orientation, shape, location) that can mitigate or eliminate glare while still prioritizing energy production. It also reports the predicted annual energy production from each potential configuration.

Ultimately, the glare analysis must result in a "no objection" finding in order to proceed with the installation. If a hazard is identified, one solution may be to change one of the aforementioned variables, at the cost of reducing their output. Ideally, the airport would have previously identified multiple potential parcels of available land to allow for a change in location, if necessary.

State and local permitting requirements for solar installations vary. Solarpermit.org provides public access to the National Solar Permitting Database, a free, community-based database that contains information on solar-permitting requirements across the U.S. The database contains a great deal of information, but relies on contributions from users so it may not be completely comprehensive or up to date in all cases. Airports should confirm the accuracy of the information with the relevant state and local authorities.

Local permits typically require an inspection and the submission of information such as the following:

- Engineered electrical plans;
- Manufacturers' installation instructions;
- Panel layout and attachment plan;
- Structural engineers report for commercial rooves; and,
- Site plan for ground-mounted systems.

For large PV systems (larger than 250 kW) a grid feasibility permit is typically required.

### 5.7.2 Wind

On the Federal level, FAA permits every structure over 200 feet tall within a certain radius of an airport or within critical flight paths. Figure 25 depicts the inclusion criteria. To determine whether a project meets FAA lighting requirements and regulations for siting, the project manager must complete and submit FAA forms 7460-1 and 7460-2.

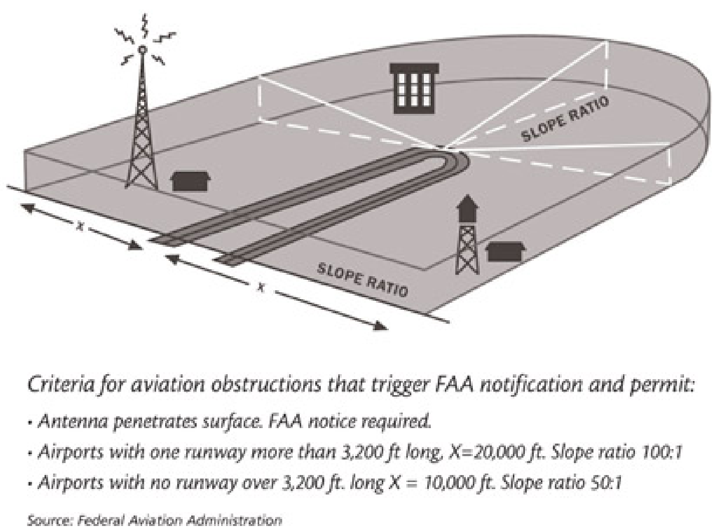



**Figure 25. Criteria for Aviation Obstructions that Trigger FAA Notification and Permit**

In some states both state and local permits are required, but in other states only the state-level requirements are applicable because they supersede local requirements. [66] Often multiple entities may need to participate in permitting and approvals. State agencies could include natural resources and environmental protection, public

[66] http://www.windustry.org/community_wind_toolbox_6_permitting_basics

utility commissions, or siting boards. Local permitters may include planning commissions, zoning boards, city councils, or a county board of supervisors.

### 5.7.3 Geothermal

Permitting requirements for geothermal systems vary. However, there are some common requirements. For example, some geothermal systems use groundwater and also discharge water into the ground, and associated permits require an analysis of how the water may impact the environment. Geothermal systems (particularly vertical systems) also have the potential to conflict with existing utilities and wells. In Minnesota, for example, an airport is required to pay a fee and complete an application form for certain types of geothermal systems. The following information is required when an airport seeks a permit for open loop and vertical systems. For an open loop system, information on well depth, location, proximity; casing depth and diameter; and type of well pump is required. To obtain a permit for a vertical system applicants must provide information on the type of heat transfer fluid used; grout material used; location of utility lines, water supply wells, and property lines. While each state or city will require different information, there are similarities jurisdiction to jurisdiction based on the type of system being installed.

# 6 Select Financing Mechanism for Carbon Reduction Measures

The ownership and financing of energy saving measures and renewable energy systems have significant implications for lifecycle cost, contractual obligations, and administrative burden. If an airport elects to use an ESA or MESA contract to complete projects, financing will not be necessary. However, if an airport chooses to use an ESPC contract or another mechanism, third-party financing may be necessary to fund the upfront costs. This section discusses financing mechanisms for energy efficiency measures and renewable energy. Public organizations most often use tax-exempt lease-purchase agreements to fund any upfront costs associated with an ESPC,[67] but there are other options. Figure 26 shows a process for selecting financing mechanisms.

Unless an airport is a private entity, it will not be able to take advantage of some of the financial incentives that make renewable energy cost effective (at least not directly). In the case where an airport is not a private entity, contracting with a third-party private company that owns that system (such as through an ESA or PPA) may be one method to take advantage of available financial incentives.

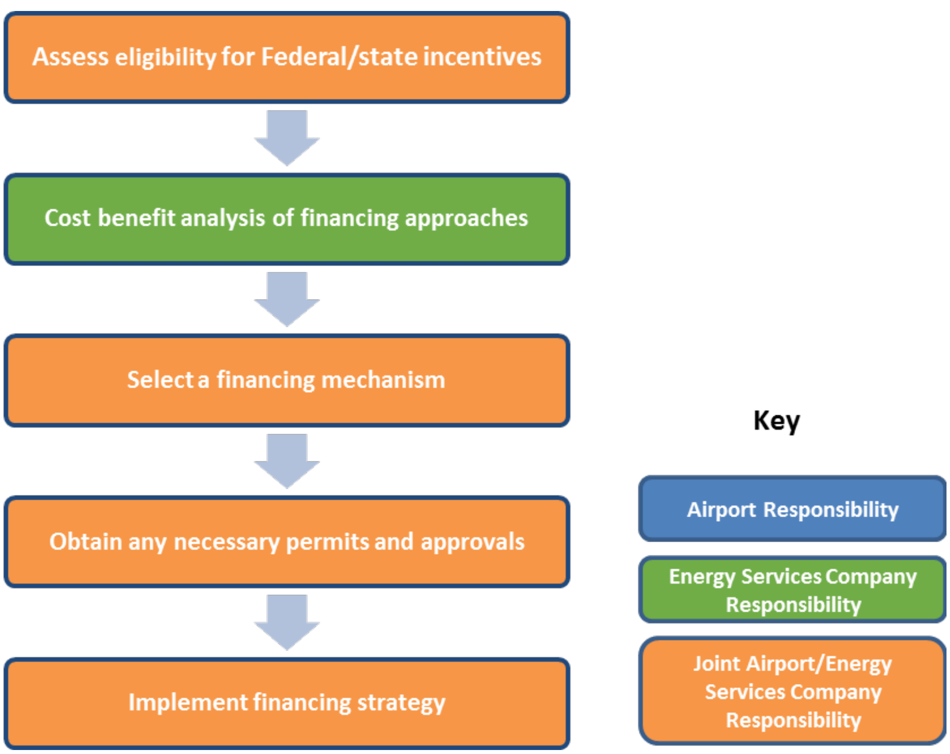



**Figure 26. Selecting Financing Mechanisms to Support Carbon Emissions Reduction**

[67] https://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf

## 6.1 Federal Financial Incentives for Renewable Energy

### 6.1.1 Renewable Electricity Production Tax Credit

The Federal Renewable Electricity Production Tax Credit, established by the Energy Policy Act of 1992, allowed corporate owners of qualified renewable energy generation facilities to receive tax credits for each kWh of electricity generated by the facility over a 10-year period. As shown in Table 7, certain facilities were eligible to receive a 2.3 cent per kWh incentive for the first 10 years of operation. Other technologies were eligible to receive a lesser value tax credit of 1.1 cents per kWh. Both values are in 1993 dollars and indexed each year to adjust for inflation, so the actual incentive is greater than it would otherwise appear. For example, the 2.3 cent per kWh incentive would actually be 3.8 cents in 2015 dollars, and the 1.1 cent per kWh incentive would actually be 1.8 cents per kWh in 2015 dollars. Since 1992, the Production Tax Credit policy has expired six times, most recently on December 31, 2014. Each time, the U.S. Congress eventually renewed it each time, including in 2015.

**Table 7. Facilities Eligible to Receive Tax Credits as Part of the Federal Renewable Electricity Production Tax Credit**

| Type of Facility | Credit per kWh (1993 dollars) | Credit per kWh (in 2015 dollars) |
|---|---|---|
| Wind | 2.3 cents | 3.8 cents |
| Geothermal | 2.3 cents | 3.8 cents |
| Closed loop biomass (using dedicated energy crops) | 2.3 cents | 3.8 cents |
| Open loop biomass (using residual waste products from other processes rather than dedicated energy crops) | 1.1 cents | 1.8 cents |
| Efficiency upgrades and capacity additions at existing hydroelectric facilities | 1.1 cents | 1.8 cents |
| Small irrigation systems | 1.1 cents | 1.8 cents |
| Landfill gas | 1.1 cents | 1.8 cents |
| Municipal solid waste | 1.1 cents | 1.8 cents |

More information is available at: http://energy.gov/savings/renewable-electricity-production-tax-credit-ptc.

### 6.1.2 Investment Tax Credit

A Federal Investment Tax Credit is available to defray the cost of investing in select alternative energy systems. The credit is a percentage of the total reimbursed system cost including materials, labor, permits, fees, taxes, shipping, and any other associated costs, minus any grants or rebates received. The Emergency Economic Stabilization Act of 2008 extended the Federal Incentive Tax Credit through 2016. However, key changes are scheduled to take effect for projects that enter service after December 31, 2016. Table 8 shows the credits that are available for various project types before and after that date.

**Table 8. Federal Investment Tax Credit, Before and After December 31, 2016**

| Type of System | Credit for Projects That Begin Service Prior to Dec 31, 2016 | Credit for Projects That Begin Service After Dec 31, 2016 |
|---|---|---|
| Solar electric and solar thermal | 30 percent | 10 percent |
| Small wind (up to 100 kW in capacity) | 30 percent | None |
| Fuel cells | 30 percent | None |
| Geothermal electricity production | 10 percent | 10 percent |
| Geothermal heat pumps | 10 percent | None |
| Micro turbines | 10 percent | None |
| Combined heat and power | 10 percent | None |
| Hybrid solar lighting | 10 percent | None |

More information is available at: http://energy.gov/savings/business-energy-investment-tax-credit-itc.

### 6.1.3 Accelerated Depreciation

The Modified Accelerated Cost Recovery System is the current U.S. tax depreciation system, used solely for income tax purposes. Under this system, the owner of tangible property can receive tax deductions each year to compensate for assumed depreciation until the total of all deductions equals the original value, or "basis" of that piece of property. The rate at which the deductions accrue and the total length of time to receive cumulative deductions equaling the basis are based on the "life" of that property. The Internal Revenue Code specifies the lives for various property classes. A shorter life (faster assumed depreciation) is beneficial for the tax payer because it allows them to recover costs in the form of deductions sooner. Certain geothermal, solar, wind, and fuel cell projects are eligible in the five-year property class, which means that the owner would be able to deduct 100 percent of the basis of that property within a five-year period. Certain biomass projects are eligible for a seven-year cost recovery. Qualified small electric meter and qualified smart electric grid systems are eligible for a ten-year cost recovery.

For equipment on which the owner claims an Investment Tax Credit (see section 6.1.2 immediately above), the owner cannot deduct 100 percent of the basis of that equipment under the Modified Accelerated Cost Recovery System. Instead, the owner must reduce the project's depreciable basis by one-half the value of the tax credit. For example, if the owner were to claim a 30 percent tax credit for a solar project under the Investment Tax Credit, they would only be able to deduct 85 percent of the basis under the Modified Accelerated Cost Recovery System.

More information is available at: www.irs.gov/publications/p946/ch04.html.

## 6.2 State Incentives and Utility Mandates

The airport should check what state-level incentives are available that would offset the cost of energy improvements and shorten the payback time. States have been increasingly aggressive in their adoption of energy efficiency programs and many offer a range of incentives that can help to finance projects. Loan and rebate programs are currently the most prevalent tools for supporting energy efficiency retrofits and other measures.[68]

Advantages of state-level financing include:

- It can help to attract additional private capital, if needed.
- Interest rates of state-level debt are typically low and in some cases the airport may be able to subordinate public capital to private debt, paying off the debt with a higher interest rate first.
- State loan and grant programs are typically processed more quickly than Federal funding.

Key considerations for seeking state-level financing include:

- The funding landscape can evolve quickly and the window of opportunity can be fleeting. For example, some state revolving loan funds solicit new projects or investments as soon as funds become available instead of through formally announced application periods or scheduled requests for proposals.
- Opportunities are sometimes issued through economic development offices or the governor's office instead of through state energy offices.

The NC Clean Technology Center maintains a searchable database of Federal, state, and local incentives that support renewables and energy efficiency in the U.S. and U.S. territories. It is available at www.dsireusa.org. Not all of the listed incentives are applicable for airports. Figure 27 shows the density of state and local incentives for renewables and energy efficiency, by state. The National Governor's Association published a State Clean Energy Financing Guidebook in 2011.[69]

[68] https://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf
[69] www.nga.org/files/live/sites/NGA/files/pdf/1101CLEANENERGYFINANCING.PDF

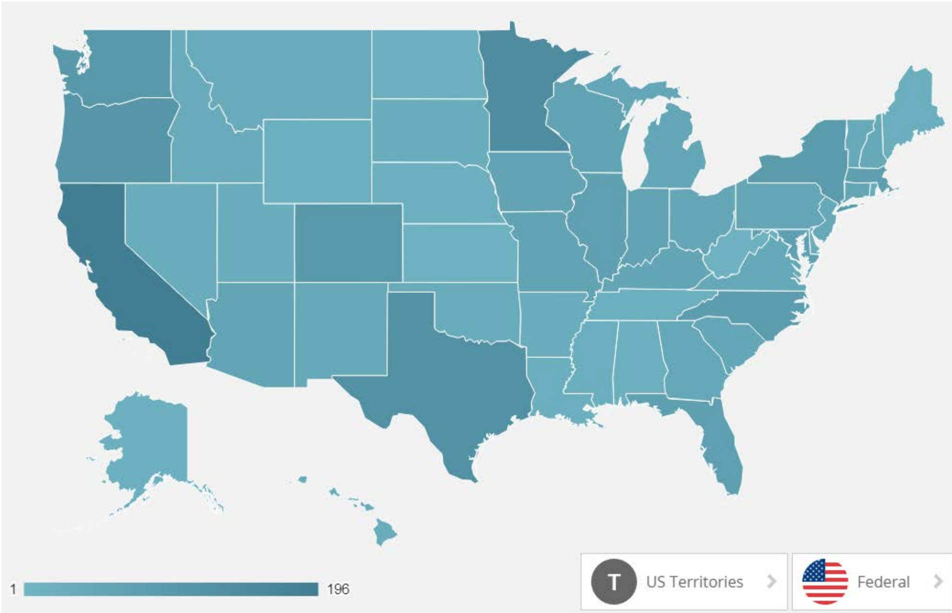



**Figure 27. Density of Federal, State, and Local Incentives for Renewables and Energy Efficiency, by State**[70]

The first incentive to verify is net metering, which is a special metering and billing agreement between utilities and their customers that facilitates the connection of renewable energy-generating systems such as solar to the power grid. Net metering credits solar energy system owners for the electricity they add to the grid and applies this credit to energy purchased from the grid. This results in continued energy savings at the prevailing cost of electricity for an airport, helping buffer against escalation and volatility in electricity prices over the life of the solar array. Forty-three states and the District of Columbia have passed net metering laws. In other states, utilities offer net metering programs voluntarily or because of regulatory decisions. Differences between states' legislation and implementation mean that the benefits of net metering can vary widely for solar customers in different areas of the country—see Figure 28.

[70] www.dsireusa.org

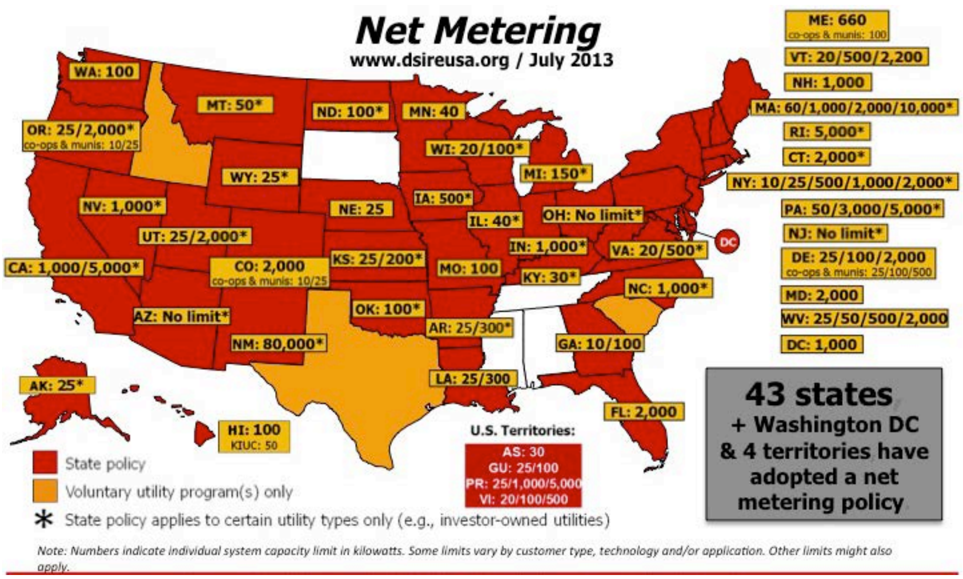



**Figure 28. State Net Metering Policies**[71]

In addition to checking net metering availability in its state, the airport should compare its cost of electricity compared to other regions, since this dictates the relative level of energy savings that the airport will receive through net metering. A higher cost of electricity results in more valuable net metering credits applied against the cost of purchased electricity from the utility. The higher the cost of electricity, the shorter the payback period and the greater the future savings after payback has been achieved. The map in Figure 29 displays regional variation in average costs of electricity across the U.S.

The second incentive to check is the existence of a Renewable Portfolio Standard (RPS) in the airport's state. If an RPS exists, Renewable Energy Certificates, the monetized environmental attribute of renewable energy separate from the produced electricity, can be sold by solar system owners to the utilities, as well as to other purchasers. Utilities in 29 states and the District of Columbia are required to produce a growing share of their electricity from renewable sources, which the utilities achieve by purchasing RECs. The proceeds from selling an airport's generated RECs to a utility in an RPS state can shorten the payback for the airport and boost the revenue stream from the solar installation.

[71] www.seia.org/sites/default/files/net-metering-map.jpg

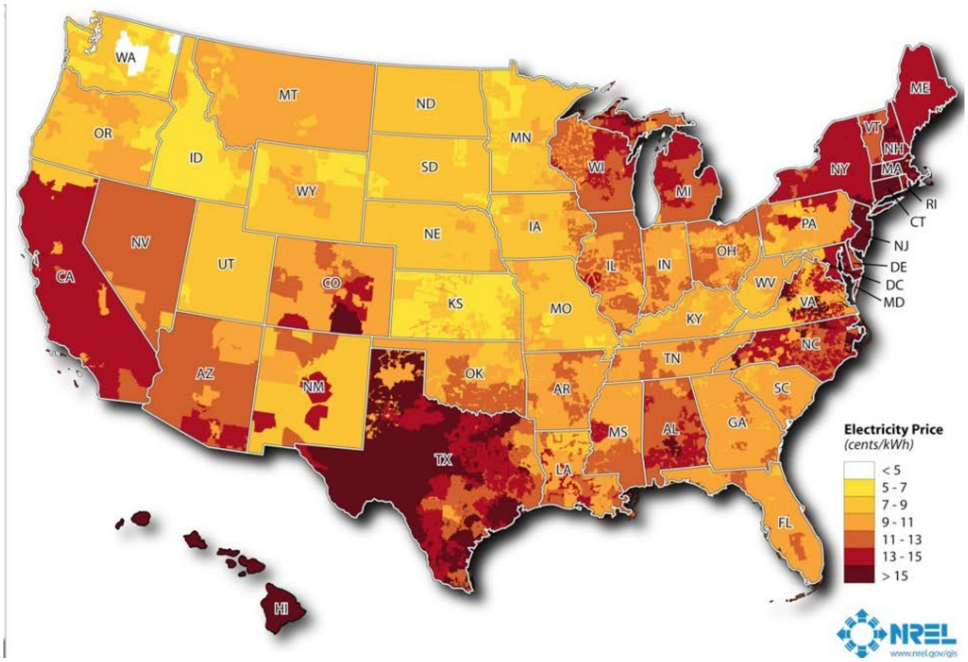



**Figure 29. Map of Average U.S. Residential Electricity Price by Utility Service Territory (2008 data)[72]**

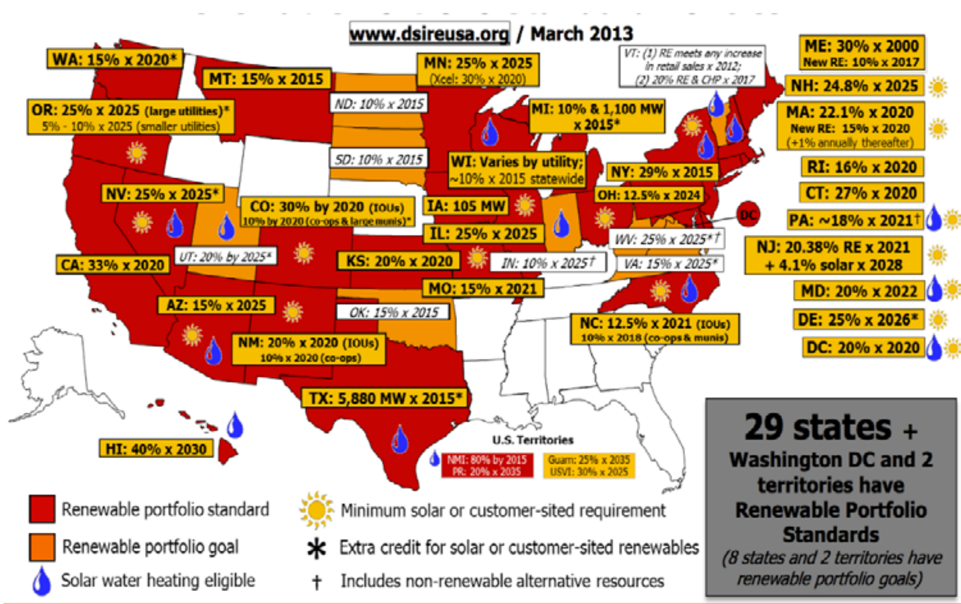



**Figure 30. Renewable Portfolio Standard Policies[73]**

Additionally, as shown in Figure 31, 16 of the states that have RPS requirements (and the District of Columbia) also have solar generation provisions that place a premium on solar-generated RECs. The additional revenue

[72] http://en.openei.org/wiki/File:Electricity_Price_Map.jpg

[73] www.tidewatercurrent.com/2014_winter/images/rps_states.png

from these solar RECs can further enhance the financials of an airport solar array.[74]

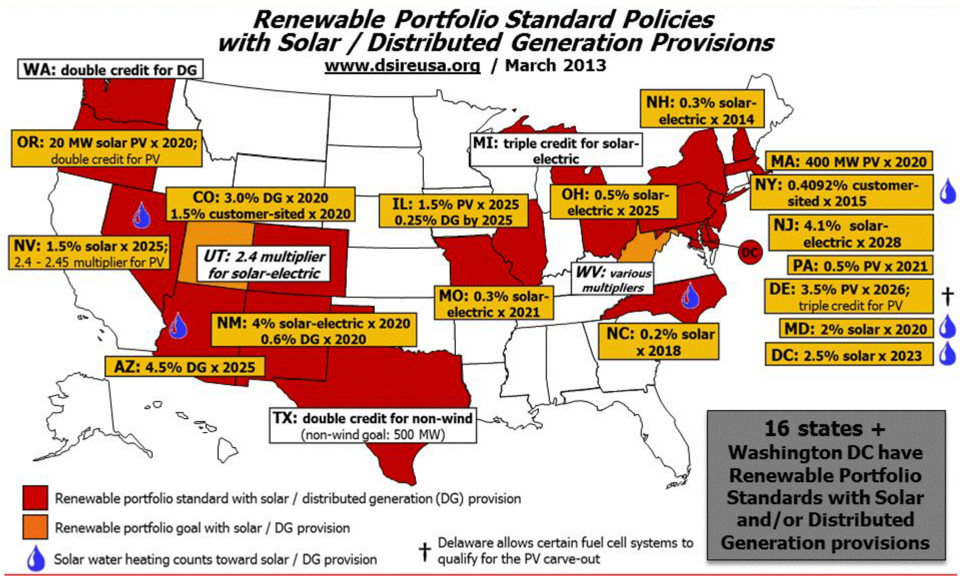



**Figure 31. Renewable Portfolio Standard Policies with Solar/Distributed Generation Provisions[75]**

## 6.3 Voluntary Airport Low Emissions FAA Grant (VALE) Program

The VALE Program is a national initiative designed to reduce sources of airport ground emissions. VALE support is available to commercial service airports located in compromised air quality areas of the country as designated by the U.S. Environmental Protection Agency (EPA). Airports can obtain VALE funding for cleaner technology that the FAA deems cost effective. Projects may include the purchase of low-emission vehicles, installation of charging infrastructure, and other infrastructure improvements. Eligible infrastructure activities for the VALE program[76] must be designed and implemented primarily for reducing emissions near the airport.[77]

## 6.4 Tax-Exempt Lease-Purchase Agreement

Leasing is a common method for financing energy upgrades and alternative energy projects when an organization cannot (or chooses not) to provide all of the upfront funding. Leases are contracts that allow an entity to obtain the use of or to purchase equipment or real estate over a period of time in return for regular payments to the lessor. Leasing allows the lessee to pay for energy upgrades with money that is already set aside in its annual utility budget. The energy savings from a project also can pay partially or fully for the

[74] Note: in certain states such as Massachusetts, the sale of RECs to utilities may cause the airport to give up its environmental attributes and therefore the ability to claim carbon neutrality from the solar array, while in other states, such as Colorado, REC sales to utilities do not carry this risk.
[75] www.nrel.gov/tech_deployment/state_local_governments/images/map_solar_dgrps.jpg
[76] www.faa.gov/airports/environmental/vale/
[77] www.faa.gov/airports/environmental/vale/media/vale_techreport_v7.pdf

financing cost of the lease. Leases often have slightly higher rates than bond financing, but they are usually a faster and more flexible tool than bonds or other financing options.

State and local governments most commonly use a tax-exempt lease-purchase agreement, also known as a “municipal lease.” This is more similar to an “installment-purchase” agreement rather than a traditional lease or rental agreement; in a lease-purchase agreement the lessee obtains the title to the equipment when the lease is signed. Only public sector lessees would be eligible to use a tax-exempt agreement. These typically offer lower interest rates than a taxable commercial lease agreement because the lessor is exempt from paying Federal income tax on the interest received.

Due to the “non-appropriation” language typically included in tax-exempt lease-purchase agreements, this type of financing may be considered an operating rather than a capital expense. As a result, the payments are not considered “debt” from a legal perspective in most states and usually do not require taxpayer approval. On the other hand, the “non-appropriation” clause transfers a certain amount of risk to the lessor, so the lessee may need to reassure the lessor that the projects in question are considered essential to the operation of the organization in order to minimize the perception of risk.

In many cases, Federal or state incentives for alternative energy projects may only be available for commercial entities and not for the public sector. For that reason, some public sector organizations may forgo the option to sign a tax-exempt lease-purchase agreement and instead opt for a taxable true lease transaction or some other arrangement in order to retain eligibility for those incentives.

More information is available at: http://energy.gov/eere/slsc/leasing-arrangements.

## 6.5 Tax-Exempt Bond

A bond is a debt investment in which an investor (debtholder or creditor) loans money to a public or private organization (the issuer), which borrows the funds for a defined period of time at a variable or fixed interest rate. Bonds can finance alternative energy projects and energy efficiency upgrades. Tax-exempt bonds generally offer lower interest rates and longer tenors (term for repayment) than most taxable bonds, so they are an attractive option for eligible public organizations. "Tax-exempt" means that the creditor would be exempt from paying Federal (and sometimes state and local) taxes on the interest received from the issuer.

“Private placement” means that a bond is sold directly to a bond purchaser without a credit rating. A “capital market bond sale” means that the bond is offered for public sale in capital markets with a credit rating provided by a bond rating agency. The minimum size for a private placement can be anywhere from $500,000 to $1 million. The minimum size for a public bond sale is typically in the range of $10 million to $20 million, if not larger. One related challenge is that loans for energy efficiency retrofits of existing facilities are sometimes small—less than a few hundred thousand dollars. For small loan sizes it can be challenging to arrange financing, streamline bond issuance procedures, manage transaction costs, and find interested bond purchasers. However, some state bond authorities have developed streamlined procedures for smaller bond issues. Some bond authorities can finance projects with their own resources, aggregate them, and then refinance with a bond issue. Alternatively, the bond authorities can work with a partner financing institution that can originate the clean energy loans, which then can be pooled together for refinancing with a bond sale.

In evaluating financing options and weighing the merits of a bond versus a lease-purchase agreement, airports should consider the net cost, which may not be the same as the stated interest rate. For example, a tax-exempt bond with a 3.5 percent interest rate may appear to be a better deal than a tax-exempt lease-purchase agreement with a 4 percent interest rate, but that may not necessarily be the case if the hidden costs of the bond outweigh the difference in interest rates. The bond may involve hidden costs based on the need to: obtain a legal opinion, set up a trustee, retain accounting services, obtain insurance, set aside a cash reserve for the first year, rate the bond (if applicable), and pay for marketing fees (if applicable). According to a 2014 EPA primer on innovative financing for energy projects, these types of additional fixed costs can easily exceed $50,000.[78] Typically, lease purchase agreements do not include any extra costs or fees aside from the interest rate (with the exception of fees to create an escrow account to manage funds during the construction period). The legal opinion for a lease-purchase agreement usually requires little or no research and can be provided by internal counsel. Furthermore, a bond may take longer to execute, which may have an "opportunity cost" to the extent that it delays the point at which energy savings can begin.

More information is available at: http://energy.gov/eere/tax-exempt-bond-financing-nonprofit-organizations-and-industries and http://energy.gov/eere/slsc/bonding-tools.

## 6.6 New Clean Renewable Energy Bond

Section 54 of the Internal Revenue Code describes regulations for the issuance and use of clean renewable energy bonds (CREBs). The CREBs program, which the Internal Revenue Service (IRS) administers, presents a low-cost opportunity for public entities to issue bonds to finance renewable energy projects regardless of project size. Each time Congress makes a CREBs authorization, the IRS issues guidance soliciting applications from qualified entities with qualified projects. In April 2009, the IRS published an application and related guidance for securing "New CREBs" allocations. Projects that were eligible for allocations included facilities that generate electricity from a variety of sources including, wind, solar, closed-loop biomass, open-loop biomass, geothermal, small irrigation, qualified hydropower, landfill gas, marine renewables, and trash combustion.

With CREBs, a type of credit bond, the federal government lowers the cost of debt by providing a tax credit to the bondholders in lieu of interest payments from the issuer. The investor receives a tax credit from the U.S. Department of the Treasury rather than an interest payment from the issuer. Because CREBs are theoretically interest free, they may be more attractive than traditional tax-exempt municipal bonds.

Tax credit bonds differ from traditional tax-exempt municipal bonds in several ways. With tax-exempt municipal bonds, the issuer makes cash interest payments. The federal government exempts interest income from federal taxes, allowing an investor to offer bond rates that are lower than those for a corporate bond of similar credit rating. With tax credit bonds, the federal government provides the investor with tax credits in lieu of

[78] http://energy.gov/sites/prod/files/2014/06/f16/COO-CFO_Paper_final.pdf

interest payments from the borrower, subsidizing municipal borrowing completely.
Early in 2015, the IRS announced the availability of nearly $1.4 billion in remaining volume cap for New CREBs. Applications for an allocation were due by June 3, 2015. It is unclear whether the CREBs program will be extended in the future; however, it has been extended several times since it was established by the Energy Policy Act of 2005.

## 6.7 Power Purchase Agreement

A PPA is a financial arrangement in which a third-party developer owns, operates, and maintains the renewable energy system, and a customer agrees to host the system, purchasing the system's electric output for a predetermined period, typically between 6 and 25 years. The arrangement allows the customer to receive stable and usually lower cost electricity that the system produces, while the electricity provider or another party acquires benefits such as tax credits and income generated from the sale of electricity to the customer.

With this business model, the host customer buys the services produced by the PV system rather than the PV system itself. The solar services provider arranges financing, design, permitting, and construction of the system, allowing the host customer to avoid high upfront capital costs. The utility serving the host customer provides an interconnection from the PV system to the grid, and continues its electric service with the host customer to cover the periods during which the system is producing less than the site's electric demand. Certain states have net metering requirements in place that provide a method of crediting customers who produce electricity on-site in excess of their own electricity consumption (Figure 32).

PPAs allow the host customer to avoid system performance risks and complex design and permitting processes. They may also save a host customer money from the day the system is commissioned. ACRP Synthesis 19: Airport Revenue Diversification describes the solar PPA that Denver International Airport established for arrays installed at the airport. Additional pros and cons of the PPA model, as facilitated through a renewable energy cooperative, are discussed below in the Barnstable Municipal Airport case study.

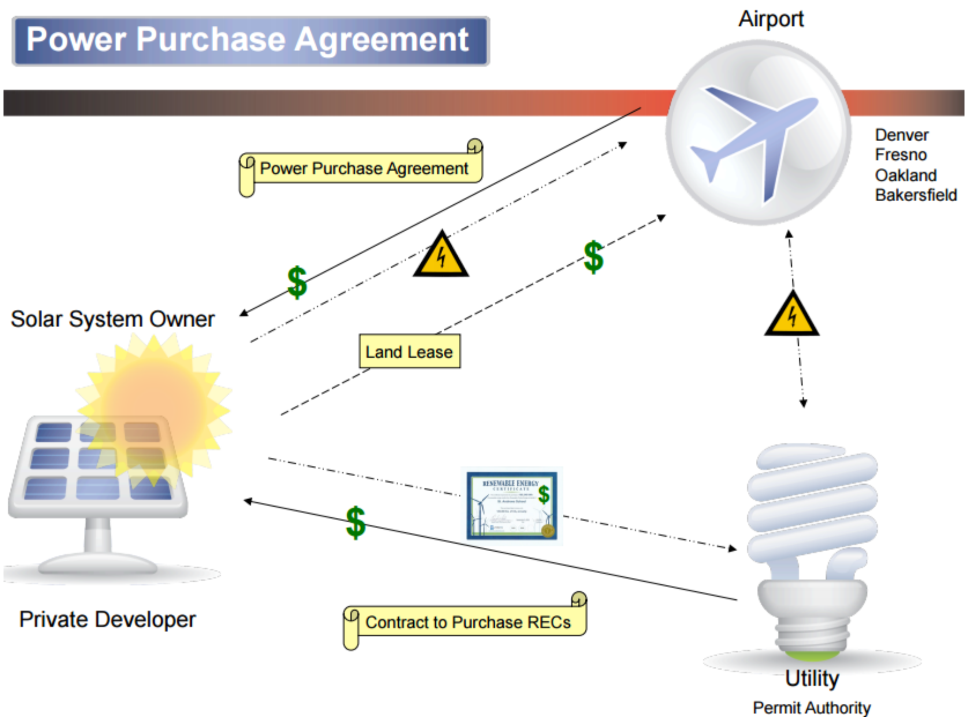



**Figure 32. Solar PPA Process for Airports**

Source: [Harris Miller Miller & Hanson Inc.]

# Case Study: Solar Through a Renewable Energy Cooperative at Barnstable Municipal Airport

The Barnstable Airport PV project was made possible by the Cape & Vineyard Electric Cooperative (CVEC), an entity created in response to the legal inability of Massachusetts towns to enter contracts for energy projects. An arrangement similar to Barnstable's, involving in-kind contribution of airport land to finance a PPA arrangement established with the technical assistance of a renewable energy cooperative could be replicated at other airports. The RFP for the project bundled 17 different sites (ground mounted as well as roof mounted), including the Airport. The Airport was the largest and most favorable of the 17 sites for the developer (about 5.7 out of 11.6 MW), allowing the same favorable rates to apply to the other smaller installations on the Cape, which otherwise would have been economically unattractive and would not have been built.

**Pros:**

CVEC provided legal, documentation, procurement, and negotiation support for PPA terms at no cost to the Airport, in contrast to hiring a consultant or retaining dedicated staff with these skills and bandwidth. Additionally, by working with the CVEC cooperative, the Airport and Town had access to lower, more favorable PPA rates. The airport's only contribution was to loan the land, and it is required to purchase solar electricity over the 20-year term of the PPA at a fixed low rate, with no escalation, while collecting net metering credits and saving about $600,000 per year on energy costs, estimated to total $14m over the 20 years. The developer guarantees at least 80 percent of the estimated production, which protects the airport against significant PV nonperformance (e.g., sinkhole, plane crash, hurricane), and insurance and bonding further de-risk the Airport. The PPA structure financially incentivizes the developer to produce as much or more than the estimated energy capacity, since doing so increases their returns.

**Cons:**

There were three cons to this approach. First, the process was slow due to the large number of stakeholders that required coordination, combined with the solar investors' changing requirements over time; the process took three years. Second, when the original developer went bankrupt, the project nearly was not built, and the subsequent change in developers has resulted in continuing litigation and poor press. At each step of the process, it has been essential to watchdog the developer and to negotiate favorable terms. Third, the PPA mechanism dilutes the savings that would be possible if the airport owned the PV assets, but the difference is reduced because the Airport itself would be unable to collect the 30 percent ITC tax incentive.

## 6.8 Property Assessed Clean Energy

The property assessed clean energy (PACE) model is a mechanism allowing some local governments, state governments, or other interjurisdictional authorities to fund the upfront costs of energy improvements on commercial, industrial, and residential properties without large upfront cash payments. PACE financing for clean energy projects is generally based on a "land-secured financing district," which is sometimes referred to as an assessment district, local improvement district, or similar term. Typically, the local government in an assessment district issues bonds to fund projects with a public purpose. Property owners, voluntarily participating, repay their improvement costs over a set time period—typically 10 to 20 years—through property assessments, which are secured by the property itself and paid as an addition to the owners' property tax bills. Nonpayment generally results in the same set of repercussions as the failure to pay any other portion of a property tax bill. Private airports located in a "land-secured financing district" could conceivably participate in a local PACE program, although it is unclear whether there are any existing examples of this.

A PACE assessment is a debt of property, meaning the debt is tied to the property as opposed to the property owner(s), so the repayment obligation may transfer with property ownership depending upon state legislation. This eliminates a key disincentive to investing in energy improvements, since many property owners are hesitant to make property improvements if they think they may not stay in the property long enough for the resulting savings to cover the upfront costs.[79] The DOE has a PACE Primer[80] that describes the process, example eligible properties and efficiency measures, and other DOE resources.

## 6.9 Nonprofit Association Established to Facilitate Renewable Energy Development[81]

Some organizations participate in energy cooperatives that pool resources in order to help members access energy resources more cheaply and efficiently. An airport may elect to participate as a member of such a cooperative, and the cooperative could help the airport facilitate renewable energy development by providing financing options, technical assistance, and a central contract for purchasing, operations, and maintenance. As described in the case study on the prior page, the town of Barnstable, Massachusetts is a member in the CVEC. Because of their membership in this association, the town was able to take advantage of a procurement process to build solar arrays at the airport.

[79] http://energy.gov/eere/slsc/property-assessed-clean-energy-programs

[80] http://energy.gov/sites/prod/files/2014/01/f7/commercial_pace_primer.pdf

[81] See project fact sheet for more details: www.barnstable-airport.com/airport/AP-Final-SolarFAQ4-22-15.pdf

**Table 9. Advantages and Disadvantages of Various Financing Solutions**

| | Advantages | Disadvantages | Adapted From |
|---|---|---|---|
| **Federal tax incentives** | • Partially defrays the cost of a project. | • Will not completely fund a project.<br>• Some incentives are only available for private entities.<br>• Incentives expire periodically, and renewal is uncertain. | http://energy.gov/savings/renewable-electricity-production-tax-credit-ptc<br><br>http://energy.gov/savings/business-energy-investment-tax-credit-itc<br><br>www.irs.gov/publications/p946/ch04.html |
| **FAA VALE** | • May partially or fully fund a project. | • Only commercial service airports located in compromised air quality areas are eligible.<br>• Only certain types of projects are eligible. | www.faa.gov/airports/environmental/vale/ |
| **Other Federal or state incentives** | • Defrays the cost of a project.<br>• Other advantages may exist for specific incentives. | • May require research to confirm eligibility, applicability, and utility.<br>• Other disadvantages may exist for specific incentives. | www.dsireusa.org |
| **Tax-exempt lease-purchase** | • Flexible terms (5-15 years)<br>• Flexible capital for funding a range of clean energy projects<br>• In most states, it is considered an operating expense rather than capital expense, so does not require voter approval<br>• Often not subject to debt limitations<br>• Tax exemption lowers costs | • Typically higher interest rate than bonds; however, the net cost may still be lower when the higher fixed costs of the bond are taken into account.<br>• Reserve fund/escrow account is typically required.<br>• "Capitalized interest" is typically required, which means that the organization cannot immediately claim the interest expenses as a tax deduction. | http://energy.gov/eere/slsc/leasing-arrangements |

| | Advantages | Disadvantages | Adapted From |
|---|---|---|---|
| | • Short development time (3 months) | | |
| **Traditional lease** | • May be one way to take advantage of Federal or state incentives that are only available for private entities. | • Higher interest rate than a comparable tax-exempt lease. | http://energy.gov/eere/slsc/leasing-arrangements |
| **Tax-exempt bond** | • Flexible capital for funding a range of clean energy projects<br>• Low cost debt due to robust security and tax-exempt interest<br>• Long terms (20-30 years) | • Considered a capital expense rather than an operating expense, so requires voter approval (in most cases)<br>• Counts against statutory debt limit restrictions<br>• High fixed issuance costs, so may only be appropriate for large projects<br>• Long development time (9 months or more) to prepare package of funding requests and gain voter support | http://energy.gov/eere/slsc/bonding-tools and http://energy.gov/eere/tax-exempt-bond-financing-nonprofit-organizations-and-industries |
| **PACE** | • Allows for secure financing of comprehensive projects over longer term, making more projects cash flow positive<br>• Repayment obligation passes with ownership, overcoming hesitancy to invest in longer payback measures. Helps some property owners deduct payments from their income tax liability | • Only applicable to private airports located within a "land-secured financing district" where a jurisdiction has set up a PACE financing program | DOE PACE Primer |

| | Advantages | Disadvantages | Adapted From |
|---|---|---|---|
| **PPA** | • Predictable pricing<br>• Upfront capital costs not needed<br>• Projects can generate cash flow from outset<br>• No system performance or operating risk<br>• Potential carbon footprint reduction | • May mean paying two separate electricity bills if the PV system does not meet the load 100%<br>• Complex negotiations and possible higher transaction costs than purchasing PV system outright<br>• Limited ability to make changes to site location as it may affect performance of PV system | Renewable Global Energy, MBE Services, Inc. |
| **New CREBs** | • Allows agency to purchase system outright without need for appropriations<br>• Low borrowing costs<br>• Does not add to general debt burden<br>• Federal tax subsidy bonds generally have 0% interest rates | • Agency responsible for long-term O&M<br>• Energy bonds are less appealing to investors<br>• Availability of tax subsidy bonds is limited; CREBs are not currently available. | NCHRP Report 751 |
| **Nonprofit Established to Facilitate Renewable Energy Development** | • Through economies of scale, a cooperative can help a small local member organization participate in hosting renewable energy facilities when it would otherwise not be economically viable.<br>• The cooperative can provide its members with access to resources (e.g., financing options, technical assistance, and a central contract for purchasing, O&M) | • Some cooperatives require that members purchase a certain percentage of their energy from the cooperative's existing generation facilities or partners, which may preclude the construction of new renewable energy facilities. | |

## 6.10 Selecting the Optimal Financing Mechanism[82]

Each of the financing and ownership mechanisms described in this section and summarized in Table 9 will need to be analyzed in a spreadsheet to determine the approach that is most favorable to the airport. The spreadsheet analysis is sometimes performed by the energy services company, assuming the company has taken on the renewable portion of the project. If the energy services company is not overseeing analysis of renewable options, the airport will be responsible for evaluation.

[82] See project fact sheet for more details: www.barnstable-airport.com/airport/AP-Final-SolarFAQ4-22-15.pdf

# 7 Address Remaining Carbon Emissions

It is possible that once all airport ECMs have been put in place and renewable energy has been installed, additional carbon emissions may still remain. This is especially true of airports with little opportunity to site renewable energy on airport land or off-site through cooperative renewable arrangements. Also, as mentioned earlier, some airports may choose to forego either the energy services contract, or renewable energy installation, or both. In either case, an airport can turn to a number of resources to offset carbon emissions. Three approaches to addressing an airport's carbon emissions are presented here: utility green pricing ("green power"), RECs, and offsets. Each of these mechanisms provides certainty that these investments will not double count carbon emissions.

The DOE Power Network[83] provides information on availability of buying green power on a state-by-state basis as well as a national overview. Each state page contains state-specific utility green power programs, retail green product offerings, and third-party financing options along with the national retail REC products and national commercial and/or wholesale REC marketers. For airports that have implemented ECMs and/or renewable energy, the financial savings realized from these measures can sometimes finance the purchase of offsets. Figure 33 shows a suggested process for addressing remaining carbon emissions.

[83] http://apps3.eere.energy.gov/greenpower/buying/buying_power.shtml

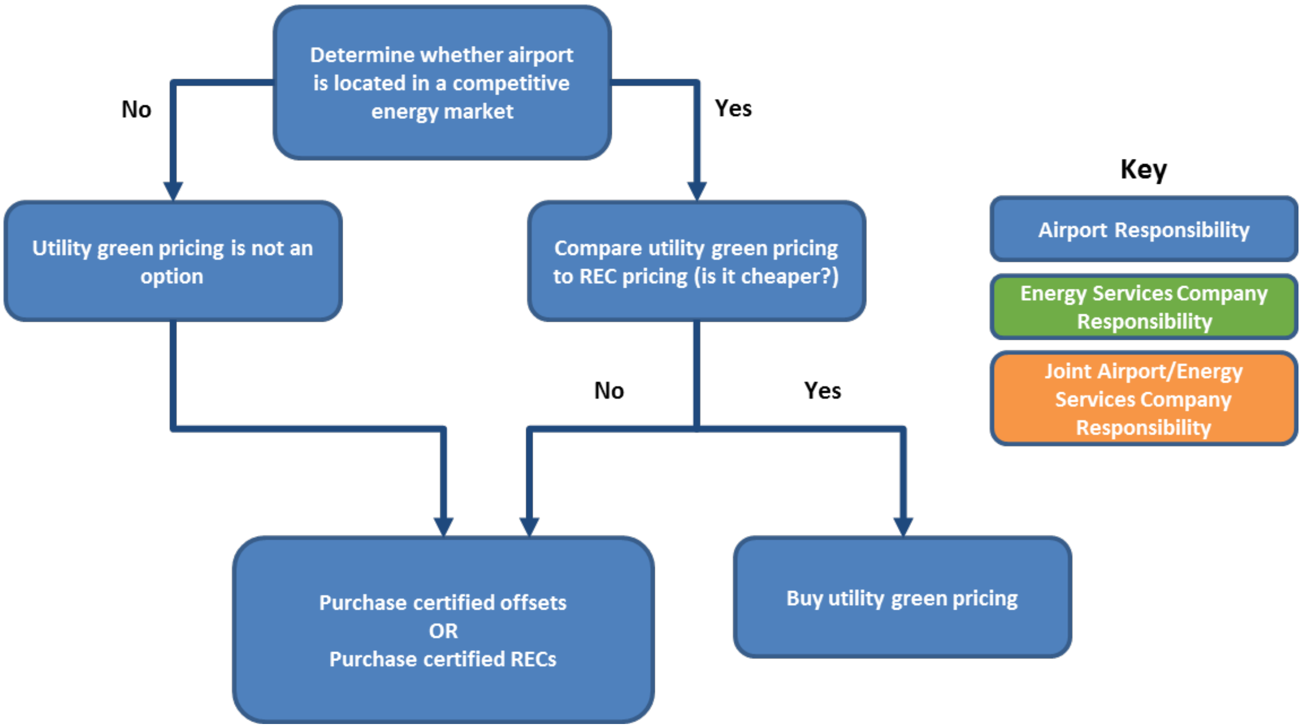



**Figure 33. Process for Addressing Remaining Carbon Emissions**

## 7.1 Utility Green Pricing

Depending on where the airport is located, it may be able to buy a green pricing product or green marketing product from the electricity provider. The airport will pay a small premium in exchange for electricity generated from renewable power resources. The premium covers the increased costs incurred by the power provider, i.e., electric utility, when adding green power to its power generation mix.[84] The purchase of green power to address remaining carbon emissions has both benefits and potential drawbacks that should be weighed (see Table 10). Table 11 and Table 12 show the green pricing programs available through utilities and through third party companies in Massachusetts as an example.

Green pricing programs can be certified by Green-e Energy (operated by the nonprofit Center for Resource Solutions),[85] an independent third party that certifies the product to meet a set of carbon accounting and environmental standards.[86] Airports and other businesses participating in Green-e Marketplace that purchase a significant amount of certified renewable energy can also display the Green-e logo to communicate their commitment to certified renewable energy. The airport should

[84] In competitive markets, airports can choose to purchase green marketing products from providers other than their local utility. In regulated markets, airports may be able to buy a green pricing product from their local utility.
[85] www.green-e.org/getcert_re_howto.shtml#UGPP
[86] See: Green-e Energy National Standard, www.green-e.org/getcert_re_stan.shtml

ensure that any utility green pricing program or competitive green power product purchased is certified by an independent body such as Green-e.

**Table 10. Benefits and Potential Drawbacks of Utility Green Pricing.**[87]

| Utility Green Pricing |
|---|
| ***Benefits*** |
| Consolidates your green power purchase and electric service into a single utility bill.<br>Can offer savings through long-term purchase contracts with your utility service provider.<br>Is typically sourced from local renewable resources within the utility's service territory. |
| ***Additional Considerations*** |
| Can be limited in terms of type and location of resources.<br>Can include fuel charges associated with fossil fuel generation. |

It is important to note that utility green pricing programs may only be available to customers located in the utility's service territory.

**Table 11. Massachusetts Utility Green Pricing Programs**

| Utility Information | Enrollment Information | Type | Start Date | Premium |
|---|---|---|---|---|
| Braintree Electric Light Department | BGreen | solar and wind | 2009 | Contribution |
| Concord Municipal Light Plant (CMLP) | Green Power | hydro | 2004 | 3.0¢/kWh |
| Shrewsbury Electric and Cable Operations | SELCO Green Light | wind | 2009 | 0.5¢/kWh |
| Wellesley Municipal Light Plant | Wellesley Renewable Energy | solar, wind and biomass | 2009 | 4.0¢/kWh |
| Source: NREL, Golden, Colorado. | | | | |

[87] www3.epa.gov/greenpower/buygp/types.htm

**Table 12. Sample of Massachusetts Retail Green Power Product Offerings**

| Company Information | Enrollment Information | Resource Mix[2] | Certification |
|---|---|---|---|
| Ambit Energy | Certified Green | wind, biomass | Green-e Energy |
| Cape Light Compact | Cape Light Compact Green 100% | 75% hydro, 16% solar, 9.1% wind | — |
| Cape Light Compact | Cape Light Compact Green 50% | 35% hydro, 7.5% wind, 7.6% solar | — |
| ClearView Electric | ClearGreen | 100% renewables | Green-e Energy |
| Energy Plus | Energy Plus Green Option | 100% wind | — |
| Great Eastern Energy | Renewable Electricity | 100% renewables | Green-e Energy |
| Green Mountain Energy Company | Pollution Free (various plans) | 100% wind | — |
| Just Energy | JustGreen Power | 100% renewable | Green-e Energy |
| National Grid/Community Energy (GreenUp Program) (5) | NewWind Energy and Small Hydro (50% or 100%) | 70% small hydro, 30% new wind | Green-e Energy |
| National Grid/Mass Energy Consumers Alliance | New England GreenStart | 25% new wind, solar and digester gas; 75% low-impact hydro | — |
| Source: NREL | | | |

## 7.2 Renewable Energy Certificates[88]

For airports that do not have access to green pricing through their electricity provider, renewable energy certificates or RECs provide another way to purchase verified and trackable carbon reductions. This allows organizations to support renewable energy development when renewable power products are not locally available.

RECs work in the following way: All grid-tied renewable-based electricity generators produce two distinct products: physical electricity and RECs. The RECs are tradeable instruments that represent proof that 1 MWh of electricity was generated from a renewable energy resource. A REC represents the property rights to the environmental, social, and other non-power qualities of renewable electricity generation. A REC, and its associated attributes and benefits, can be sold separately from the underlying

[88] More information will be added based on follow up from NREL Strategic Energy Analysis Center.

physical electricity associated with a renewable-based generation source. RECs convey the attributes and benefits of the renewable electricity, not the electricity itself. Purchasing RECs to address remaining carbon emissions carries benefits and potential drawbacks, as summarized in Table 13.

**Table 13. Benefits and Potential Drawbacks of Purchasing RECs**[89]

| RECs |
|---|
| ***Benefits*** |
| Provides flexibility when green power products are not otherwise locally available.<br>Allows you to maintain existing relationships with utility service providers.<br>Serves as a practical product option for leased space environments when you may not have direct control of its utility service relationship.<br>Allows you to specify product sourcing requirements such as resource type, location, and vintage.<br>Allows you to scale the size of your green power purchase.<br>Price premiums can be less than other “bundled” products.<br>Potential to make claims about being solar powered (if associated RECs are retained).<br>Potential reduction in carbon footprint (if associated RECs are retained). |
| ***Additional Considerations*** |
| Does not provide a financial hedge against rising energy costs.<br>Can be a challenge to communicate the concept of RECs to stakeholders. |

RECs are independently audited by utility commissions and programs to ensure that only one customer claims credit for each REC, and the MWh of renewable electricity generation and delivery it represents. These programs require third party verification of the RECs to be performed by an independent certified public account or a certified internal auditor. Regional tracking systems assign a unique serial number to each REC to ensure that they are not counted twice. When a customer purchases and uses a REC, whether to maintain compliance with a regulatory program or to make a voluntary claim, the serial number associated with that REC is “retired” and cannot be used again. [90]

REC prices are dependent on several factors: technology, year generated (vintage), volume purchasing, region of generation, eligibility of REC, natural gas prices, and other factors. Table 14 provides a list of retail REC products.

89 http://www3.epa.gov/greenpower/buygp/types.htm
90 http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml?page=3

**Table 14. National Retail REC Products (as of January 2015)[91]**

| Certificate Marketer | Product Name | Renewable Resources | Location of Renewable Resources | Residential Price Premiums* | Certification |
|---|---|---|---|---|---|
| 3Degrees | National Renewable Energy Certificates | 100% wind, solar, geothermal, low-impact hydro, biogas, biomass | Nationwide | 0.5¢/kWh-1.5¢/kWh | Green-e Energy |
| 3 Phases Renewables | Green Certificates | 100% biomass, geothermal, hydro, solar, wind | Nationwide | 1.2¢/kWh | Green-e Energy |
| Arcadia Power | Wind Energy | 100% new wind | Nationwide | 0.5¢/kWh-1.5¢/kWh | Green-e Energy |
| Bonneville Environmental Foundation | Renewable Energy Certificates | wind, low-impact hydro, biogas, landfill gas, geothermal, solar | Nationwide | 0.8¢/kWh | Green-e Energy |
| Carbon Solutions Group | CSG CleanBuild | biomass, biogas, wind, solar, hydro | Nationwide | .15¢/kWh - .5¢/kWh | Green-e Energy |
| Community Energy | NewWind Energy | 100% new wind | Nationwide | 2.5¢/kWh | Green-e Energy |
| EDP Renewables | US Wind | 100% wind | Nationwide | 0.8¢/kWh | — |
| GP Renewables & Trading LLC | GP-REC Structured Product | solar, hydro, biomass, landfill gas, energy efficiency | Localized by state and region | 0.2¢/kWh | — |
| Mass Energy Consumers Alliance | New England Wind Friends | 100% new wind | New England | 5.0¢/kWh (contribution) | — |
| North American Power | American Wind | 100% wind | Nationwide | 1.5¢/kWh | Green-e Energy |
| NuPath Energy | NuSource1 | wind, solar | Nationwide | 1.2¢/kWh | Independent 3rd party |
| NuPath Energy | NuSourceNY | wind, small hydro | NY/nationwide | 1.6¢/kWh | Independent 3rd party |

91 http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml?page=0

| Certificate Marketer | Product Name | Renewable Resources | Location of Renewable Resources | Residential Price Premiums* | Certification |
|---|---|---|---|---|---|
| Renewable Choice Energy | American Wind | 100% new wind | Nationwide | 2.0¢/kWh | Green-e Energy |
| REpowerNow | REpower Credits | wind, solar, hydro | Wisconsin | 2.5¢/kWh | — |
| Santee Cooper | SC Green Power | landfill gas, solar | South Carolina | 3.0¢/kWh | Green-e Energy |
| Sky Energy, Inc. | WIND-E Renewable Energy | 100% wind | Nationwide | 2.4¢/kWh | — |
| Sterling Planet | Sterling Wind | 100% new wind | Nationwide | 1.5¢/kWh | Green-e Energy |
| WindCurrent | Chesapeake Windcurrent | 100% new wind | Mid-Atlantic States | 1.5¢/kWh | — |

Notes:
* Product prices are updated as of January 2015. Premium may also apply to small commercial customers. Large users may be able to negotiate price premiums.

Source: NREL.

*ACRP Report 57 The Carbon Market - A Primer for Airports* further examines the potential opportunities that RECs present for airports.[92] Although the focus is on the airport as the renewable energy host, rather than prospective buyer, the report provides an in depth review of how airports can participate in emerging carbon and other environmental markets.

## 7.3 Offsets

A carbon offset is a reduction in GHG emissions made in order to compensate for an emission made elsewhere. Carbon offset programs fund projects that reduce GHG emissions to balance the emissions from other sources. In purchasing carbon credits to offset emissions, an airport would work through an offset organization, such as TerraPass or the Carbon Neutral Company, to finance efficiency, renewable energy, forest protection, or reforestation projects globally.[93]

Carbon offsetting works by purchasing carbon credits generated from a variety of projects that can demonstrate that they would not otherwise be financially viable without the sale of carbon credits and that they achieve GHG reductions additional to what would have occurred without the project. Carbon credits generated are assigned unique identification numbers that are tracked and then retired when an

[92] http://www.trb.org/Main/Blurbs/166411.aspx
[93] www.carbonneutral.com/

organization, such as an airport, purchases the credit.[94]

The concept is similar to programs that some airports have established whereby air passengers are able to purchase offsets, often at kiosks within terminal buildings, to compensate for the emissions generated from their flights. Similarly, the International Air Transport Association has published guidelines and a toolkit on carbon offset programs[95] for airlines. Although the guidelines set out a systematic approach to establishing an offset program for air carriers, the process described is a useful resource for airports as the key principals are the same.

As mentioned earlier, Green-e is a national independent certification and verification program for renewable energy and GHG emissions with its two programs: Green-e Climate and Green-e Energy. Green-e Climate is a certification program for the sale of GHG emission reductions sold in the voluntary market. It ensures that Certified Offsets contain only verified reductions from projects that meet high-quality, endorsed standards, and that participating offset sellers deliver correct volumes and types of emissions reductions on behalf of their customers. Green-e Climate also enforces customer disclosure requirements to ensure offsets are as advertised and that full and accurate information is provided to the consumer. The certification ensures that no double selling of GHG emission reductions occurs and that sellers make appropriate disclosure to their customers. Additionally, Certified Offsets can only be sourced from projects that were validated and registered under a Green-e Climate Endorsed Program. These programs use standards that ensure that projects are additional, and that reductions are real, verified, enforceable, and permanent.

Once the airport has reviewed the options available to offset remaining carbon emissions, purchase of the RECs or offsets is needed. This Chapter provided links to retailers of products that can be used to reduce any remaining carbon emissions. If, as noted earlier, an airport does not want to enter into an energy services contract or install on-site renewable energy, carbon neutrality can be achieved solely with REC and/or offset purchases.

[94] www.carbonneutral.com/resource-hub/carbon-offsetting-explained

[95] www.iata.org/whatwedo/environment/Documents/carbon-offset-guidelines-may2008.pdf)

# 8 Other Considerations

## 8.1 Communicating the Benefits of the Program

Communicating the benefits of a carbon neutral airport program can improve an airport's public image, educate, and positively influence other organizations and individuals, as well as garner support for continued sustainability efforts. A variety of ways exist to portray information on the program, such as through signage, brochures, or public service announcements. Figure 34 and Figure 35 offer an example of how a brochure might appear, and the types of information that an airport may choose to include.

**FACT SHEET: Carbon Neutral Airport**

**What is a Carbon Neutral Airport?**

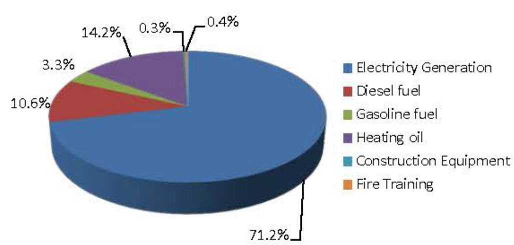
- A carbon neutral airport does not produce greenhouse gas (GHG) emissions from its operations on a net basis.
- Emissions on a "net basis" are measured annually, thus airport-controlled operations may produce emissions on a given day, but over the course of a year the net emissions are zero.

**What is the Significance of Today's Announcement?**

- The airport has a detailed plan to achieve carbon neutrality.
- Today's announcement marks the commencement of the implementation phase of the program.

**What are the Major Sources of GHGs at the Airport and Which Sources are Being Reduced?**

- Aircraft emissions are excluded from the program since they are defined as an uncontrollable emission source.
- The GHG emissions reduced as part of this program are: carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons.




**How is Carbon Neutrality Achieved?**

- First, numerous energy conservation measures will be implemented that together will reduce the existing energy consumption at the airport by 35%.
- These measures include the installation of both indoor and outdoor LED lighting; retro commissioning of major mechanical systems (including energy recovery ventilators); building envelope improvements; a cross-building integrated building management platform; highly efficient infrared garage heating; boiler burner replacements; and other measures.
- To reduce the remaining 65% of GHG emissions resulting from airport operations, arrays of solar photovoltaic panels between 1.5MW and 2.1MW are being considered to generate enough energy to supply or offset the remaining energy consumption at the airport, which results in net zero GHG emissions.
- Solar thermal technology is also planned to reduce heating oil use for water heating.

**Figure 34. Example Fact Sheet to Publicize a Carbon Neutral Airport Program (page 1)**

**FACT SHEET: Carbon Neutral Airport**

**What are the Anticipated Benefits of the Program?**

- The Program, when fully implemented, will eliminate nearly 1,000 metric tons of carbon emissions each year at The airport (the same as the carbon sequestered after planting 94,017 tree seedlings and growing them for 10 years[1])
- Project participants will develop expertise and document lessons learned which will benefit other airports within the region and nationally.
- Significant upgrades will be made to the airport facility equipment.
- The airport will have reduced exposure to electricity price volatility with on-site power generation.
- Reduces need and costs for infrastructure to meet energy demand.

**What are the Steps in the Program?**

- Phase I began in October 2012 and was completed in April 2014. This included:
  - Solicitation of proposals from airports and the selection of the airport;
  - Development of technical reports such as a comprehensive GHG baseline for the airport;
  - Solicitation of and review of proposals for an energy services company to enter into a contract with the Airport;
  - Selection of the energy services company.
- Phase II (Implementation)
  - Implementation of energy conservation measures and renewable energy installations.

**How Is the Program Financed?**

- An energy services company guarantees savings on energy and water/sewer bills over a 20-year term to pay for the project.
- The airport (or a third party) finances the project through tax exempt lease/bonds, utility incentives, grants, or other mechanisms and makes payments using funds saved from lower energy bills.
- In addition to savings on energy bills, the sale of renewable energy credits (RECs) will also provide funding for the project.
- Rebates from utilities and other approaches will also be used to reduce initial program costs.

1 http://www.epa.gov/cleanenergy/energy-resources/calculator.html

**Figure 35. Example Fact Sheet to Publicize a Carbon Neutral Airport Program (page 2)**

## 8.2 Intersections with Resiliency

Many of the measures that an airport may pursue toward carbon neutrality may also provide ancillary benefits in the form of energy resiliency. ECMs may reduce an airport's reliance on energy and the vulnerability to disruptions in energy supply. On-site renewable energy, if supplemented with on-site battery storage may also help to create a more reliable energy supply in the event of a disruption in grid-supplied energy.

## 8.3 Carbon Accreditation

Participating in a voluntary carbon accreditation program can help an airport validate its carbon neutral status and publicize this through an unbiased third party. A variety of programs are available, but the following are most relevant:

- The ACA Program is specifically intended for airports that intend to inventory and manage their GHG emissions. It offers certification at four levels, and the most demanding of those levels (level 3+) requires an aim of carbon neutrality. ACA also developed the ACERT now updated as version 3.0. ACERT is a spreadsheet tool for calculating airport GHG emissions. Airports are not required to use the tool in order to attain certification with ACA. Regardless of level, the program requires that airports employ an independent third party to verify each GHG inventory.
- The CarbonNeutral Protocol is a reporting framework and accreditation program for organizations seeking to demonstrate carbon neutrality. It is not limited to airports, but at least one airport in North America (Gander International Airport in Canada) has participated. The organization also sells third-party verified carbon offsets.
- The Climate Registry (TCR) is not limited to airports, but there are several airports that choose to report their GHG emissions inventories to TCR. However, even the most demanding of its certification levels (platinum level) do not require or verify carbon neutrality. It only requires a 20 percent reduction in emissions.

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