Microgrids: Opportunities and challenges for US airports

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STEVEN L. OSIT
Partner, Kaplan Kirsch & Rockwell, USA

Steven Osit is a partner at Kaplan Kirsch & Rockwell LLP, where he represents public entities with respect to the development and operation of airports throughout the United States. Steven advises airport sponsors on a wide range of federal regulatory matters involving the Federal Aviation Administration, Transportation Security Administration, and other federal agencies and counsels clients on the delivery of complex airport development projects. Steven also represents airport sponsors in administrative and judicial litigation arising out of regulatory compliance issues and other disputes with airport users and businesses. Steven is a certified private pilot.

Kaplan Kirsch & Rockwell, 1675 Broadway, Suite 2300, Denver, CO, 80238, USA
Tel: 1-303-825-7000; E-mail: sosit@kaplankirsch.com

SARAH M. KEANE
Partner, Kaplan Kirsch & Rockwell, USA

Sarah Keane is a partner at Kaplan Kirsch & Rockwell LLP, where she focuses on regulated transactions, litigation, and policy matters involving electric power, clean transportation and climate change. Sarah regularly counsels clients on pertinent legal and regulatory developments in the areas of climate change, electric vehicles, renewable energy, energy storage and electricity grid management. She also advises a wide range of project developers and sponsors regarding asset development, purchase and sale, with a particular focus on renewable energy and transmission projects. Sarah assists project proponents regarding compliance with federal and state environmental compliance and helps them secure the full suite of local, state and federal entitlements.

Kaplan Kirsch & Rockwell, 1675 Broadway, Suite 2300, Denver, CO, 80238, USA
Tel: 1-303-825-7000; E-mail: skeane@kaplankirsch.com

Abstract

It is currently standard practice for airports in the United States and around the world to depend largely on their local electric utility for most day-to-day power needs, while having on-site back-up generation that can run essential operations during power outages or other emergencies. But recent cost declines and technology advances have made it possible for airports to install full microgrids, capable of supplying most or all of their basic power needs. While a microgrid can offer significant resiliency, cost and local control benefits for an airport, the sponsor needs to weigh many interrelated operational, legal and financial considerations to ensure a successful microgrid project and avoid unintended regulatory consequences. Among key areas to consider are structuring project governance and delivery, funding options, facility siting and potential environmental review, revenue use and diversion, and risks of utility regulation.

Keywords

power generation, renewable energy, microgrid, resiliency, cost savings

INTRODUCTION

Airports are complex operational environments comprised of interrelated systems, all purpose driven to ensure the safe, secure and efficient movement of people, property and airplanes. One

indispensable component of all of these systems? Power.

Airports are significant drivers of energy consumption associated with air travel. Airports' unique and critical functions require additional consideration towards, and protection of, the resilience and reliability of their power supplies. Power outages affecting airports can not only impart a ripple of delays and frustrations but also seriously impact the safety of landside and airside operations. Further, the substantial size of an airport's energy needs adds a layer of complexity when considering how or whether to address climate and local pollution impacts of power generation.

It is currently standard practice for airports in the United States and around the world to depend largely on their local electric utility for most day-to-day power needs, while having on-site back-up generation (usually diesel-powered generators) that can run essential operations during power outages or other emergencies. Over the past several years, some airports have turned to solar or other local power generation alternatives to power discrete systems, such as obstruction lighting, fuel farms or parking systems. But as methods for delivering and storing power continue to evolve, often accompanied by steep cost declines, airports should continue to evaluate their options for meeting more — or all — of their energy requirements less expensively and more sustainably.

Across all infrastructure types in the country, current market trends show an unprecedented amount of growth in microgrid demand and implementation.[1] This paper will provide a brief, conceptual overview of microgrid power systems and their benefits and then will discuss possible legal implications for US airports considering the implementation of these innovative power solutions.

WHAT ARE MICROGRIDS?

Until relatively recently, public infrastructure operators have had little choice but to depend on local utilities for their power needs, colloquially referred to as 'the grid'. Electricity was almost always centrally generated at large power plants and then transmitted to all of a utility's users, and energy storage was not widely used. It would have been cost prohibitive for all but the largest and most energy-intensive infrastructure projects to have on-site power generation for day-to-day needs. But the rapid acceleration of distributed energy generation and storage technologies, coupled with steep cost declines, has recently made on-site power generation and storage an affordable and attractive alternative in a wide range of applications.

The US Department of Energy defines 'microgrid' as 'a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act[] as a single controllable entity with respect to the grid'.[2] Although they come in a wide variety of configurations, a microgrid is, in essence, a self-sustaining unit capable of generating, distributing and storing power within its bounds. While a microgrid can be established with a connection to the local utility grid, most microgrids connect to the grid and share power across that interconnection while the grid is functioning but are capable of functioning independently during grid outages — so-called 'island' mode. In this way, a

microgrid resembles the current back-up generation that most airports already rely upon but would provide a great deal more optionality and flexibility to airport sponsors.

Microgrids can be configured according to project needs and desires, including choice of generation and storage methods, amount of generation capacity, and which facilities or operations can be served. Driven both by energy and climate policy objectives and by price declines, new microgrid projects in the United States are increasingly relying on solar energy and battery storage, although natural gas and diesel generation also remains common.

Depending on the goals of the project, microgrids can result in cost savings, increase resiliency, mitigate transmission challenges, provide environmental benefits and address reliability issues in the main grid. They can also contribute to reduction in energy sprawl because they are scalable to community size and do not require land-intensive transmission infrastructure. Critically, microgrids can improve both reliability and resiliency, two related but distinct concepts. Reliability refers to the frequency of outages at a site, whereas resilience refers to the ability of a site to respond to a contingency situation. By providing a redundant layer of electricity, a microgrid improves reliability. By creating a certain access to energy for loads on the grid and remaining durable in the face of potential damage, microgrids can enhance resiliency.[3]

WHY WOULD AN AIRPORT WANT A MICROGRID?

Reasons for wanting to develop a microgrid vary significantly across projects, but three key trends emerge: resiliency, customisation and cost.

Resiliency. Airport sponsors already well understand the need to provide back-up power when the local utility grid experiences a power outage. Now that many US airports are facing the prospect of increased frequency or intensity of natural disasters that threaten to interrupt reliable power supply, including flooding, hurricanes, wildfires, and more intense and frequent thunderstorms, the need for an on-site power solution has become more acute. Additionally, rising temperatures in many parts of the country pose threats to existing power systems by limiting transmission capacity during peak hours for air conditioning systems.[4]

The ability to operate independent of the grid adds a level of versatility that enhances the resiliency of the airport power supply beyond what a back-up generator can provide. For example, if extreme temperatures create a demand crunch, the independent power supply ensures that the airport can continue operating at full strength. Having a secure power supply on site reduces the chance of a storm elsewhere in the region impacting the ability for the airport to function. Moreover, microgrids offer an opportunity to remove a massive power draw from the public utilities grid, potentially reducing the likelihood of a climate-related outage in the first place.[5]

The airport industry has already grappled with incidents that might have been mitigated in part by increased reliance on on-site power generation. In 2017, for example, an 11-hour power outage ravaged service scheduled to, from and through Hartsfield-Jackson International Airport, resulting in nearly 1,200 cancelled flights.[6] Indeed,

that outage motivated Pittsburgh's officials to consider localised power and eventually commit to a full microgrid power solution at the Pittsburgh International Airport, and it has sparked several similar discussions at other airports.

Customisation. One of the largest advantages that microgrid power provides lies in the customisability of their configuration. If a site is situated near large natural gas reserves, for example, then the microgrid can be designed to draw its power from that local resource, whereas airports in sunny climates may want to rely especially heavily on solar power. Generation and storage choices may also be driven by renewable energy or emissions reductions policies applicable to the city, county or state in which an airport operates.

Cost. Historically, receiving power from the local distribution utility was reliably the cheapest option for airport sponsors, but that is starting to change in many situations, driven in large part by cost declines for solar and energy storage technologies as well as natural gas supply. Especially where a publicly owned airport can rely on relatively inexpensive sources of up-front capital or can partner with private sector entities for financing, developing power generation and storage may provide significant long-term savings as compared to the cost of grid-supplied power. Also, by minimising the risks of power outages, airports can protect against revenue losses that would be sustained from the need to cancel flights or reduce concession sales. Microgrids can, in some situations, also offer opportunities to generate revenue through the sale of excess generated energy as well as renewable energy credits or other tradeable instruments where the power is generated from renewable technologies.

Each of these benefits of microgrids for airport sponsors must be weighed against potential drawbacks, however. In particular, airports must be prepared for the additional complication of operating and maintaining the various components of a microgrid and have contingency plans to address outages from the airport's generation resources. For microgrids that typically run in island mode, proper coordination with the local utility may open avenues for emergency connection of a microgrid to the utility's grid.

MICROGRID PROJECT EXAMPLES

Several airport microgrid projects already underway highlight the potential advantages, and variety of approaches, to developing independent power generation facilities. The range of different approaches highlights the scalability of microgrid solutions for different size airports and their unique concerns.

Pittsburgh International Airport's ongoing transition to complete microgrid power is poised to become a landmark achievement in the development of resilient, localised power generation and supply for airports. The project, which began construction in spring 2020 and is anticipated to be complete in summer 2021 as part of the airport's Terminal Modernization Program, will include 20 megawatts (MW) of gas-fired generation, spread across five separate generators, and an additional 3 MW of ground-mounted solar generation. Because the airport's peak power demand is only about 14 MW, the microgrid will also be able to serve the power needs of a hotel and gas station on the airport property. The full

cost of the project is US$30m, with US$25m going towards gas generators and US$5m spent on solar panels. Instead of prioritising a reduction in emissions, the Pittsburgh Airport sought proposals that would meet resilience and reliability requirements, with the use of renewables encouraged but not required.

One unique feature of the Pittsburgh project is the funding structure. The project will be financed, built and operated by Peoples Natural Gas, a local utility company, resulting in no upfront costs for the airport. The airport signed a 20-year services agreement with Peoples and will pay nothing beyond a monthly electricity bill going forward. The grid will be completely owned, operated and financed by Peoples, with the expectation that they will earn back their initial investment through gas sales to the airport. The Pittsburgh Airport expects to see at least US$500,000 per year in electricity savings compared to their current bill and will continue to pay a nominal fee to maintain access to the grid for backup power. The airport has right of first refusal to 100 per cent of their energy needs, with Peoples able to sell any excess electricity to the grid. While emissions were not the priority, the airport expects to see a net reduction in greenhouse gas emissions compared to regional power because of the solar component of the project and increased efficiency.[7]

Smaller airports are also joining the trend. Redwood Coast Airport, located in Humboldt County, California, serves 50,000 flights annually. The ongoing construction of a 7-acre, 2.25 MW solar array and battery storage system was funded by a US$5m grant from the California Energy Commission and US$6m in matching funding by the Redwood Coast Energy Authority. The project includes a 250 kilowatts (kW) net metered system to offset daily electricity usage at the airport, 2 MW of wholesale solar power to go back onto the grid, and 2 MW of battery storage that provides 8 megawatt-hours (MWh) of energy storage. Operations are split among several different agencies and utilities, with the total project supporting 20 electric accounts, including the airport. The projected is expected to provide solar power to 430 homes and reduce carbon dioxide emissions by 880 metric tons.[8]

Chattanooga Metropolitan Airport, another midsized airport, serves 61,000 flights annually. Tasked with reducing the utility bill, the largest expense for the airport, a microgrid not only solved that problem but also made use of airport land that could not house a building because of Federal Aviation Administration (FAA) flight restrictions. The 12-acre, 2.74 MW solar farm meets the full energy needs of the airports, making Chattanooga the first fully solar-powered airport in the United States. When the project began in 2010, Chattanooga was in non-attainment for PM 2.5, so they were able to secure funding for the first phase of the project through an FAA Voluntary Airport Low Emission Grant, a programme available to airports in non-attainment areas. The final two phases of the US$10m project were funded through FAA Section 512 energy efficiency grants. The airport expects to recoup US$5m in investment costs over the next 20 years in the form of saved operating costs.[9]

Several other smaller microgrid projects are under development or in operation at US airports. Detroit Metropolitan Airport partnered with DTE Energy to construct a solar array

at the airport in 2015, providing an additional 750 kW of electricity to the facility.[10] This solar array is part of the on-site microgrid that provides a total of 17 MW of back-up generation for the airport.[11] John Wayne Airport in Orange County, California, has likewise engaged with the architecture and engineering firm Arup to design a 2.4 MW solar microgrid with 8 MWh battery storage.[12]

These case examples showcase the wide range of microgrid projects and their ability to achieve different goals. The Pittsburgh International Airport prioritised increased reliability and resiliency, while the Redwood Coast project focused on reducing emissions and the Chattanooga Airport sought to reduce their long-term utility bill. Each project was able to meet their main goals and achieve significant co-benefits as well. It is important to note that while the midsized airports chose to prioritise solar, there is nothing prohibitive about larger airports operating off a solar microgrid. Cochin International Airport in India became the first solar-powered airport in the world in 2015, with a 29.5 MW array serving 10 million annual passengers.[13]

LEGAL ISSUES RELATED TO MICROGRID DEVELOPMENT

While microgrids may be enticing from a number of operational perspectives, associated legal implications are a vital consideration for any interested airport sponsor.

Project Governance and Delivery

One of the first considerations for airport sponsors considering a microgrid project is whether to contract with a third-party private developer or to develop and/or operate a microgrid themselves.

Where a third party develops a microgrid on airport property, the airport sponsor will generally enter into a ground lease and development agreement for the construction of the project and a power purchase agreement (PPA) securing a long-term rate for the electricity generated by the microgrid. Under such a governance model, it is important to ensure that the transaction is structured in compliance with FAA requirements. For example, the FAA's policies on the use of airport revenue and self-sufficiency generally require an airport to receive fair market value (FMV) for any non-aeronautical use of airport property. An airport sponsor also may not generally sell airport property to a private developer without a formal release from the FAA or extend lease terms that would exceed 50 years.

A microgrid owned by an airport sponsor, on the other hand, may allow it to retain more of the benefits of the project and avoid some of the regulatory hurdles described here. Not only this includes savings on (or the elimination of) its regular utility bills, but it may also allow the airport to sell excess power back to the grid (ie net-metering revenue), monetise renewable energy credits resulting from the project, and/or take advantage of other federal or state incentives for the development of alternative power generation systems. In this situation, however, the airport sponsor may need to take on more of the up-front financing, as described in the following section.

In all cases, it is essential that the airport sponsor maintain adequate control

and oversight of the project to ensure compliance with state and federal regulatory requirements.

Funding Mechanisms

Before an airport elects to finance and develop its own microgrid, it is also important to be aware of various limitations on potential funding mechanisms. In some cases, general municipal revenues, state and federal grant programmes, or private investment may be sufficient to manage the significant up-front capital investment often required of a microgrid project. In most cases, the use of airport revenue to finance the construction of a microgrid is permissible, as an airport's power needs are considered an operating cost of the airport, and a capital project to reduce those costs or enhance the resiliency of such services would also be permissible. Airport sponsors may also be able to finance capital costs by issuing debt, including through general airport revenue bonds, or project-specific financing mechanisms, such as clean renewable energy bonds.

At the time of this writing, however, there are relatively few opportunities for federal financial participation on an airport microgrid project. Standalone microgrid projects are not currently eligible under either the Airport Improvement Program (AIP) or Passenger Facility Charge (PFC) Program, unless they are an integral component of a larger, eligible project. Nevertheless, it is important to consult with the Airports District Office (ADO) early on in exploring the possibility of a microgrid. Notwithstanding the general limitations on AIP and PFC funding, support may be available under the FAA's Voluntary Airport Low Emission (VALE) Program, depending on the location of the airport and associated air quality and the airport's existing modes of power generation. Discretionary AIP grants may also be available for conducting preliminary assessments of a microgrid project under Section 512 of the FAA Modernization and Reform Act of 2012,[14] which established funding for projects designed to increase energy efficiency at airports.

Airport sponsors should be aware, however, that the use of federal funds in support of a microgrid project may have significant project delivery implications, including subjecting the project to Buy American requirements or triggering additional environmental review. The source of funds for a microgrid, and any associated project constraints, must be carefully evaluated.

Siting and Potential Environmental Review

Airports that have received federal funds under the FAA's AIP are obligated to comply with the terms of their grant agreements with the United States, which impose a number of operational and economic restrictions typically referred to as the 'grant assurances'.[15] Among these grant assurances, airports are required to operate in a 'safe and serviceable condition', protect the terminal airspace from hazards to aircraft operation, and ensure that surrounding land use is compatible with normal airport operations. Airports are also generally required to maintain an FAA-approved airport layout plan (ALP) that depicts all existing and proposed facilities at the airport, including areas reserved for non-aeronautical

purposes, and to ensure that all development activity is in conformity with the ALP.

Until relatively recently, the FAA's role in overseeing airport development was a potentially significant barrier to the timely and cost-effective delivery of a microgrid project. To the extent that a microgrid was not already depicted on an approved ALP or was considered for siting on airport property that had not been reserved for non-aeronautical purposes, airport proponents of a microgrid were early on required to obtain the FAA's approval of a modification to the ALP. Such FAA approval, moreover, was considered a 'federal action' that triggered the need for environmental review under the National Environmental Policy Act of 1970 (NEPA).

But recent changes in the law may substantially reduce federal oversight of airport development and, depending on site selection and microgrid components, may eliminate the need for environmental clearance entirely.[16] Through Section 163 of the 2018 FAA Reauthorization Act, Congress expressly prohibited the FAA from regulating the 'acquisition, use, lease, encumbrance, transfer, or disposal of land by an airport owner or operator', except to ensure the safety and efficiency of airport operations and that the sponsor receives fair market value for the property, at least to the extent the subject property was not acquired with federal assistance.[17] The act also modified the FAA's review and approval authority over ALPs by limiting it to reviewing only those portions of the ALP that would 'materially impact the safe and efficient operation of aircraft' and the 'safety of people or property on the ground adjacent to the airport as a result of aircraft operations' or those that would 'adversely affect the value of prior Federal investments to a significant extent'.[18] While still in its relative infancy, Section 163 may provide a strong basis for airport sponsors to move forwards with a microgrid project, depending on its characteristics, without having to complete an amendment to the ALP or associated environmental review.

That is not to say, however, that the FAA's oversight of a microgrid project is insignificant. Microgrid components must conform to certain airspace restrictions designed to ensure safe take-offs and landings, as well as maintain compatibility with airport design standards.

The FAA requires public notice of construction and improvements on airports, in part to ensure that projects will not impact the efficient use and preservation of airspace. The FAA will review, for example, whether microgrid components will penetrate volumes of airspace needed for aircraft' safe approach to and departure from the runway environment, whether structures will generate electromagnetic interference with surveillance radar or distract pilots or airport traffic control tower personnel through glare or glint, and whether project components could produce thermal plumes over sensitive areas of aircraft operation. This may restrict an airport sponsor's choice of power generation mechanisms. For example, many tall generators, including wind turbines, may pose too many logistical problems to be successfully implemented near the runway environment, despite potential suitability for energy production in the area. Other possible microgrid technologies, such as natural gas-fired generators or

solar panel arrays, may also result in unique aeronautical impacts that must be reviewed by the FAA.[19]

Revenue Use and Diversion

In addition to the grant assurances summarised earlier, airport sponsors are also subject to significant restrictions on the use of airport revenues.[20] Airport revenues are generally considered all 'fees, charges, rents, or other payments received by or accruing to the sponsor' as a result of its or its tenants' activities, including the sale of resources that will be taken from the airport.[21]

Revenues generated on airport lands, including those derived from on-site resources, must be utilised strictly for the capital or operating costs of the airport, the local airport system, or a substantially related and commonly owned or operated facility.[22] It is therefore important to ensure that any revenue derived from on-site power generation (whether through net-metering revenue, the sale of renewable energy credits or other means of revenue generation) is not misappropriated.

Utility Regulation and Energy Sales

Airport sponsors will need to be wary of the classification of their potential microgrid systems. Although the details vary state by state, most states only allow regulated utilities to sell or provide electricity to any other entity. Accordingly, an airport that uses a microgrid to provide electricity to tenants or other third parties may be putting itself in the position of a utility, potentially becoming subject to additional regulation at the state level and by the Federal Energy Regulatory Commission. In many instances, this additional layer of regulatory burden can be avoided through careful planning and coordination with local energy utilities or potentially through classification as a municipal utility that may exempt the operator from most regulatory requirements. Airport sponsors must also be aware of what existing franchise agreements are in place between the utility and the local municipality or jurisdiction, which may provide for exclusive service by the utility in that area.

Relatedly, airport sponsors should carefully consider the options for excess energy production. Many microgrids are designed to produce more energy than is needed at most times of the day. Others, especially those powered by renewable resources, may produce excess energy during high production times but require the grid to supply some energy during low production times. If excess energy produced by a microgrid is not all being stored on site for later use, the airport sponsor may wish to sell the extra electricity back to the utility. This may be possible, depending on the requirements of the relevant state and local electric utility, and may provide either an additional revenue stream or a reduction in utility costs for the airport sponsor (subject to the revenue use restrictions summarised earlier). Where allowed, resale to the local utility will almost certainly come with additional regulatory or contractual considerations regarding rates of resale power generation capacity.[23]

In addition, before an airport sponsor can directly provide electricity to the airport and tenants on the property, it must analyse any contractual relationships between the utility and airport users. Existing provisions in tenants' agreements may pose issues if the tenant

has arranged a long-term pricing agreement with the public utility.

CONCLUSION

Implementation of microgrid systems at airports in the United States may bring substantial savings on energy costs for many airport sponsors, increase their resiliency in the face of natural disasters, and help further progress towards sustainable and independent power. There are many interrelated operational, legal and financial considerations that must be explored to ensure a successful airport microgrid project, and in order to avoid unintended regulatory consequences. Ultimately, any decision regarding a possible microgrid installation should be made under sound legal counsel and careful communication with the local utility and federal regulators.

AUTHORS' NOTE

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