Solar Energy Lifts Off at Airports Around the Globe

Solar Power Augments Copper Usage

(Pictured Above) A solar PV system installed at Minneapolis–Saint Paul International Airport

Why should solar-powered airports be developed?

Looking out of an airplane window during takeoff or landing, one may well ask "Why not"? Small industrial-scale installations of solar panels could easily be imagined filling the acres of land around the airport runways. That vision is already being realized at major airports in the U.S. and around the globe as solar costs drop and incentives increase.

Along with the rise in solar energy, copper usage also is on the rise. Photovoltaic (PV) solar installations are copper-intensive, partly because sunshine is dispersed over wide areas and also because the voltages must be stepped up. Copper's superior conductivity is needed to conduct amperes and connect voltages to the grid; in some cases, copper is needed to drive motors that tilt the solar panels toward the sun. "Copper intensity" is a figure of merit that has been developed to estimate the amount of copper in various renewable energy projects. Copper intensity varies depending on how far the solar plant is from the energy customer. It has been estimated that every megawatt (MW) of solar capacity in commercial solar applications uses three to six tons of copper, i.e., the copper intensity is equal to 3-6 tons/MW. Copper's durability and efficiency keep these systems running reliably and at higher efficiencies.

Why Airports?

Airport environs are quite attractive for solar projects. Typically, the land is unsuitable for other uses because of noise from low-flying aircraft; the airport itself represents a single, large customer immediately adjacent to the project. Furthermore, airports and airfields are frequently situated in areas where existing electrical rates and surcharges are well above average. Large airports may be near large cities where demand is high; smaller airfields may be in remote locations with limited infrastructure.

There are tens of thousands of airports or airfields around the globe. Many of these sites were specifically chosen as flat stretches of land near a city, town or other population center. According to the CIA World Factbook, there are 41,788 airports or airfields visible from the air in 236 countries. The U.S. has by far the most with 13,513 and Brazil is second with 4,093.

The data from 2013 includes closed or abandoned installations but not those that are no longer recognizable (overgrown, no facilities, etc.). The runways may be paved or unpaved, and not all airports have accommodations for refueling, maintenance or air traffic control.

As a high estimate, if an average of one megawatt peak (MWp) capacity were installed at each of these airfields, then an electrical infrastructure of about 40 gigawatt peak (GWp) capacity could be developed around these airports. That would be a substantial fraction of the global cumulative capacity of PV solar power, which stood at about 200 GWp at the close of 2015 and is expected to double or even triple by 2020.

Again, as a high estimate, copper usage for 40-GW capacity would be nearly a quarter million metric tons. One terawatt of capacity would require six million metric tons of copper, or less than one-third of the total copper mined in one year. Fortunately, the usage of copper in PV is sustainable, because copper is a highly recyclable material. Copper is not burned in the production of energy but can be reused or recycled at the end of the life cycle of the solar energy installation, which may be 25 years or more. In fact, copper's recycling rate is higher than that of any other engineering metal.

According to data compiled by the U.S. Geological Survey (USGS), world copper mine production (rounded) was 18.7 million tons in 2015 with reserves of 720 million tons. Note that "reserves" is defined differently than identified and undiscovered "resources." A 2014 USGS global assessment of copper deposits indicated that identified resources contain about 2.1 billion tons of copper and undiscovered resources contain an estimated 3.5 billion tons. In other words, copper deposits are plentiful in the Earth's crust. Mining capacity can be ramped up as more copper is required for the development of solar energy.

A Gradual Approach

The use of solar energy at airports has developed gradually. Ten years ago, airports experimented with installations that provided a few hundred kilowatts peak power. Nowadays, two, five or 10 megawatt installations are not uncommon and the economics are much improved as grid parity is approached.

India

For example, Cochin International Airport (CIAL), serving the city of Kochi in the Indian state of Kerala, is the busiest and largest airport in the state and the fourth-busiest in the country [Airport Code: COK] **(Figure 1)**. The airport serves more than 5 million people annually.

A modest 100-kWp solar PV plant was installed on the rooftop of its Arrival Terminal Block in 2013, and capacity was gradually increased to 1.1 MWp with additional projects expected in the next few years. More recently, CIAL added a large 12- MWp capacity PV plant on 45 acres near the International Cargo complex.

FIGURE 1.

Cochin International Airport in India installed a solar PV plant on the rooftop of its arrival terminal. PHOTO CREDIT: Vikram Solar Private Limited

Components for the large scale project included PV modules of 265 Wp capacity manufactured by Renesola and inverters of 1 MW capacity manufactured by ABB India. The energy output of the new plant is 48 MWh per day in addition to the existing plant's production of 4 MWh per day. The total output of 52 MWh per day, or about 18 GWh per year, is sufficient to meet all the power requirements of the airport. The CIAL structure is a grid-connected system without battery storage. A power banking module was negotiated with the Kerala State Electricity Board (KSEB). CIAL provides power to the KSEB grid during daylight hours and buys power back when needed (especially at night).

Many smaller airports around the globe are also already producing electricity or have plans to do so as illustrated by the following examples.

Africa

George Airport became Africa's first solar-powered airport in 2016. Midway between Cape Town and Port Elizabeth, George Airport serves about 600,000 individuals annually. The solar power plant on the grounds of the airport will gradually be increased to deliver 750-kWp power. It is managed by state-owned company Airports Company South Africa, which manages nine airports in South Africa and aims to eventually run all of its nine airports on a mix of renewable energy.

The Caribbean

In the Caribbean, a 3-MWp solar plant at Antigua International Airport began generating electric power in 2016. It will deliver up to 4.6 GWh per year, meeting most of the electricity needs of the airport and reducing the country's imports of fossil fuels.

United States

Solar plants of various sizes are already operating at airports across the U.S.

Tampa Electric installed a 2-MWp system at the Tampa International Airport **(Figure 2)**. A canopy of solar panels on the top floor of a parking garage began generating electricity for customers and shade for parking patrons in February 2016. It's Tampa Electric's first large-scale solar power plant.

The largest solar array in Minnesota is at the Minneapolis-St. Paul Airport where a 3-MWp system was switched on in December 2015. Its 8,705 solar panels are expected to supply 20 percent of the electricity used in Terminal One **(Figure 3)**.

In Massachusetts, a 6-MWp solar array was installed on the former Palmer Metropolitan Airfield **(Figure 4)**. It provides energy to the towns of Leicester and Spencer, and to Worcester State University. Although not part of a currently operating airport, it is the first and largest such facility to be built through a state program that incentivizes development of solar on landfills and brownfields. The Palmer Airfield was cleaned up after 75 years of operations dating back to the 1920s.

The San Diego International Airport is currently in the midst of a solar PV project with more than 3-MWp currently online and operational. Once fully completed, the system will produce 5.5 MWp of solar capacity for the airport. In its first year of operation, it is expected to generate nearly 9,200 megawatt hours of electricity – enough power to offset a projected 10 to 13 percent of the airport's energy needs.

FIGURE 2.

Tampa International Airport A 2-MWp solar energy system tops a parking garage at Tampa International Airport

FIGURE 3.

8,705 solar panels supply 20 percent of the power used by Terminal One in Minneapolis–Saint Paul International Airport

FIGURE 4.

This solar project in the San Diego International Airport will supply 10-13 percent of its energy needs

Experience Matters

Airport solar has been extensively studied by the Federal Aviation Administration (FAA) and affiliated consulting firms. The FAA published a 162-page document titled "Technical Guidance for Evaluating Selected Solar Technologies on Airports" in 2010. This document is regularly updated. It covers safety issues such as airspace penetration, interference with radar and glare, as well as feasibility and finance.

California solar airports described in the original "FAA Solar Guide" include a 2.4-MWp array at the Fresno Yosemite International Airport (Airport Code: FYI); a 756-KWp array at the Metropolitan Oakland International Airport; and a 744-kWp array at Meadows Field in Bakersfield. Installations in other states include a 2-MWp array at the Denver International Airport (DIA) and a 146-kWp solar array at the Albuquerque International Airport. Comparing these decade-old case studies with more recent solar projects, the trend toward larger solar arrays is evident.

Taking it to the Next Level

In light of the falling prices and growing interest in solar energy, one could ask the following questions:

How much solar capacity could be realized at the airports and airfields of the U.S. in the next decade?

How much copper wiring would be used in developing this energy resource?

As mentioned above, the total number of airports or airfields recognizable from the air has been tabulated by the CIA World Factbook. The most recent data (2013) lists 13,513 in the U.S. alone.

Airports vary widely in size. Passengers handled per year can range from less than one million to greater than 40 million. In the U.S., according to the new Part 139 Airport Certification Status List (ACSL) and related data from the FAA, there are 394 "Class I" airports, of which 29 are major hubs. Further, there are 31 Class II airports; 29 Class III; and 79 Class IV airports. Table 1 shows the types of carrier operations for these classes, and details about the requirements for certification at each class level are given on the FAA website.

Assuming an average of 2 MWp capacity were installed at each of 500 airports, the overall gain in solar energy capacity would be one gigawatt. This infrastructure could be installed in the U.S. in a relatively short period of time. The economics, feasibility and safety would need to be studied on a case-by-case basis. Based on current trends, investments at each site could be recouped by way of lower energy costs for the airports and also by selling excess capacity to utilities.

The copper intensity is estimated at 3-6 tons of copper per megawatt of solar energy. Copper intensity is a relatively fixed number that is not likely to change. Copper usage for one gigawatt solar capacity would range from about 3,000 to 6,000 tons, depending on the designs of the solar arrays.

As PV solar plants become economically attractive and environmentally desirable, airports and airfields in the U.S. and abroad are obvious sites for the PV installation. The scale of these projects continues to increase, yet there is much untapped energy considering the many airports and airfields on the planet. Copper usage in the development of these solar plants can be estimated based on past installations and is typically about 3-6 tons per megawatt. The installed copper is not consumed but is a re-usable resource, further contributing to the sustainability of solar airport projects.

Table 1

Air Carrier Operations at each Part 139 Airport Class	394	31	29	79
Type of Air Carrier Operation	Class I	Class II	Class III	Class IV
Scheduled Large Air Carrier Aircraft (30+ seats)	X			
Unscheduled Large Air Carrier Aircraft (30+ seats)	X	X		X
Scheduled Small Air Carrier Aircraft (10-30 seats)	X	X	X	

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