International Conference on Applied Energy 2020
Dec. 1 - Dec. 10, 2020, Bangkok / Virtual
Paper ID: 707

The Airports Photovoltaic Potential in China

Mingkun Jiang[1,3], Lingfei Qi[2,3], Jianing Chen[4], Ziyi Yu[5], Dadi Wu[5], Nanzhi Wang[6], Xinhai Yu[1], Jinyue Yan[1, 3,*], Wendong Wei[7,*]

1 Key Laboratory of Pressure Systems and Safety (MOE), School of Mechanical and Power Engineering, East China University of Science and Technology, Shanghai, China

2 School of Mechanical Engineering, Southwest Jiaotong University, Chengdu 610031, China

3 School of Business, Society and Energy, Mälardalen University, Västerås 72123, Sweden

4 School of Mechanical Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China

5 School of Optical-Electrical and Computer Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China

6 School of Energy and Power Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China

7 School of International and Public Affairs, Shanghai Jiao Tong University, Shanghai 200030, China

ABSTRACT

Airports have terminal buildings that are ideal places to deploy PV panels, which is able to power airport in an eco-friendly way with low carbon footprint. evaluate the PV potential at airports and its economic performance can help to understand the benefits airport PV will bring is important for decision-making. Thus, combining GIS data, image recognition, the PV integration potential at airports in China has been investigated. According to our research, airport PV potential is up to 2.67 GW in China. Detailed economic analysis manifests that all airport PV can be profitable.

Keywords: Photovoltaic, Airport, China, techno-economic analysis

INTRODUCTION

With the development of economy, flying has become the preferred mode of travel for many people. As an important facility of the aviation industry, the airport connects the ground and the sky. Airports, while convenient for people to get around, also bring problems of energy consumption and pollution. Airports can use as much electricity as smaller cities, and particulate emissions are not negligible.[1; 2]

The use of renewable energy to meet the electricity needs of airports is also a practical solution.[3; 4] For all the research, photovoltaic power generation is a method of generating electricity with fewer technical obstacles. In recent years, with the reduction of the cost of photovoltaic systems, the combination of photovoltaic and other industrial and commercial applications is more common.[5] More than 100 airports around the world have installed photovoltaic systems.[6] Due to the huge horizontal level of the terminal, it is ideal for integration with the airport. For example, Cochin International Airport is believed to be the first airport in the world to run entirely on solar power. A 12-megawatt solar farm has been deployed near the airport and is expected to save 300,000 tons of carbon dioxide over 25 years.[7; 8]

China's civil aviation industry will continue to develop rapidly in the future, which will greatly increase energy consumption and lead to environmental problems such as emissions. People are paying more and more attention to the negative effects of airports. Therefore, it is necessary to find a more sustainable way to help airports make the transition to a sustainable way of using energy.

METHOD

Airport available area screening

After investigation, we believe that the total area of the terminal, boarding gallery, and parking lot are all ideal places for arranging solar panels. Therefore, the available area of the three parts of each airport is counted.

Selection and peer-review under responsibility of the scientific committee of the 12th Int. Conf. on Applied Energy (ICAE2020).

Potential capacity and generation

The potential capacity is calculated as:

$$capacity = \frac{area_{avaliable}}{area_{PV}} \times P_{\max}$$

where *capacity* is the potential capacity of PV system (kW), P_{max} is the wattage of PV panels which is 365W in this study.

According to GB 50797-2012,[9] the annual PV generation can be calculated as:

$$E_p = H_A \times \frac{P_{AZ}}{E_S} \times K$$

where E_p is the PV output (kWh), H_A is the local horizontal irradiance (kWh/m^2), E_S is the standard PV test condition (1000 W/m^2), P_{az} is the capacity of the installed PV system (kW), and K is the overall performance coefficient, which was 0.78 in this study.[10; 11]

And the total electricity generation during lifespan is calculated as:

$$E_{total} = \sum_{i=0}^{25} E_{p,i} * K_d^{\ i}$$

where E_{total} is the total electricity generation of PV system(kWh), $E_{p,i}$ is the output of PV system in year i, K_d is the annual degeneration rate of PV panels, which is 0.9 in this study.

RESULT

Technical potential

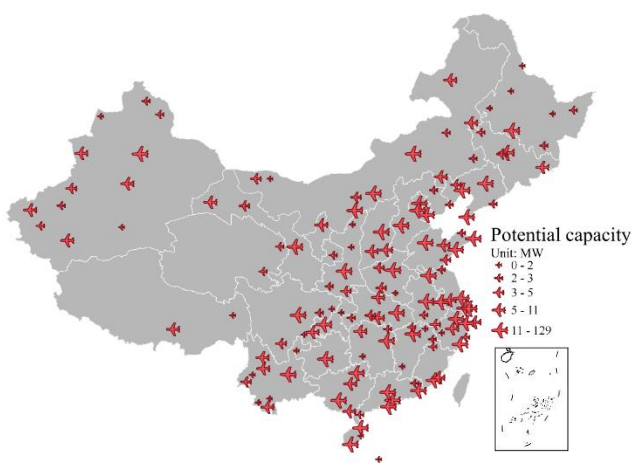

Fig 1. The distribution and potential PV capacity of airports in China.

Figure 1 shows the distribution and potential capacity of Chinese airports. The cumulative potential is 2.67 GW. The potential capacity of 22% of the airports is over 10 MW, the value of 63% of the airports lies between 1 MW to 10 MW. Referencing to the traffic data, we found that airports with higher traffic have higher PV potential. Among all airports, 9 are located in solar resource level 1 areas (≥1750 kWh/(m^2•a)), 128 are located in solar resource level 2 areas (1400~1750 kWh/(m^2•a)), 92 are located in solar resource level 3 areas (1050~1400 kWh/(m^2•a)), and 8 are located in solar resource level 4 areas (<1050 kWh/(m^2•a)). Therefore, the vast majority of airports are located in areas with abundant solar energy resources, which is critical to their power generation. The airports with the strongest solar radiation are located in Tibet. They are NAO, RKZ and LXA. The annual radiation is 2174, 2174, and 2065 kWh/m^2. The airports with the lowest sunshine are all located in Sichuan Province. They are NAO, YBP and CTU with annual radiation of 1030, 1012 and 938 kWh/m^2. Total annual potential generation of all PV systems in airports is 2.97 TWh.

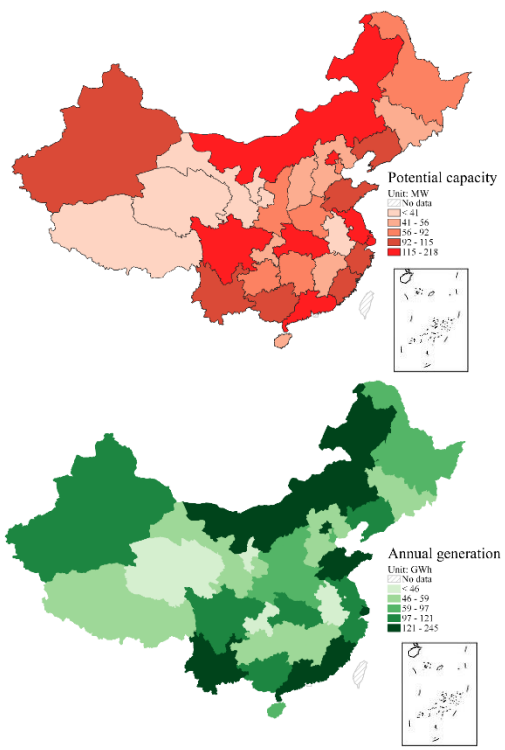

Fig 2. The provincial distribution of airport PV potential (left) and generation potential (right) in China.

Figure 2 shows the geographical distribution of The airports. The regions with the highest potential capacity are Guangdong, Beijing, Shanghai, Sichuan, Inner Mongolia, Hubei and so on. The regions with the lowest capacity are Qinghai, Ningxia and Tibet. The regions with the highest power generation

potential are Guangdong, Beijing, Shanghai, Inner Mongolia, Fujian and so on. The regions with the lowest potential is still Qinghai, Ningxia and Tibet. By comparing to potential capacity, we can find that the ranking of potential generation is close to the ranking of potential capacity. The similarity indicating the potential capacity is much majored impactor than solar resource.

CONCLUSION

In this work, we estimated the PV potential of 237 Chinese airports. The result shows the total capacity reaches 2.67 GW, and the annual generation is up to 2.97 TWh. Airport PV potential in China is significant, should be taken serious as a pathway for sustainable transition. In the future, a more detail work should be conducted to evaluate the economic performance and so on.

ACKNOWLEDGEMENT

The work is supported by National Key Research and Development Program of China (2018YFE0196000).

[1] Hudda N, Gould T, Hartin K, et al. Emissions from an International Airport Increase Particle Number Concentrations 4-fold at 10 km Downwind[J]. Environ Sci Technol, 2014, 48(12): 6628-6635.

[2] Gopalakrishnan B, Ramamoorthy K, Crowe E, et al. A structured approach for facilitating the implementation of ISO 50001 standard in the manufacturing sector[J]. Sustainable Energy Technologies and Assessments, 2014, 7: 154-165.

[3] Brouwer A S, Van Den Broek M, Zappa W, et al. Least-cost options for integrating intermittent renewables in low-carbon power systems[J]. Appl Energy, 2016, 161: 48-74.

[4] Bogdanov D, Farfan J, Sadovskaia K, et al. Radical transformation pathway towards sustainable electricity via evolutionary steps[J]. Nat Commun, 2019, 10(1): 1077.

[5] Yan J, Yang Y, Elia Campana P, et al. City-level analysis of subsidy-free solar photovoltaic electricity price, profits and grid parity in China[J]. Nature Energy, 2019, 4(8): 709-717.

[6] Icao. A Focus on the production ofrenewable energy at the Airport site[R]. ICAO.

[7] Sukumaran S, Sudhakar K. Performance analysis of solar powered airport based on energy and exergy analysis[J]. Energy, 2018, 149: 1000-1009.

[8] Sukumaran S, Sudhakar K. Fully solar powered airport: A case study of Cochin International airport[J]. Journal of Air Transport Management, 2017, 62: 176-188.

[9] Aqsiq M A. Photovoltaic power station design specification. 2012.

[10] Verso A, Martin A, Amador J, et al. GIS-based method to evaluate the photovoltaic potential in the urban environments: The particular case of Miraflores de la Sierra[J]. Solar Energy, 2015, 117: 236-245.

[11] Ito M, Komoto K, Kurokawa K. Life-cycle analyses of very-large scale PV systems using six types of PV modules[J]. Current Applied Physics, 2010, 10(2, Supplement): S271-S273.