The impact of sustainable energy on sustainable development of airport ground handling

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Aviation Business
Thesis
2024

Abstract

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Degree

Bachelor of Aviation Business

Report/Thesis Title

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Number of pages and appendix pages
36

With the development of The Times, the aviation industry occupies a very important share in the global public transport market. Airport ground handling plays a crucial role in the aviation industry, including a range of services such as baggage handling, aircraft refueling, maintenance and passenger assistance. As the world shifts towards sustainability, airports are increasingly exploring new sources of energy to reduce their environmental impact. This paper examines the impact of new energy technology on the sustainable development of airport ground handling, and will take Beijing Capital International Airport, which is the most advanced in new energy in China,as a case study.The new energy of ground handling has a positive impact on sustainable development.

First of all, this paper gives a detailed explanation of the background and significance of the new green airport. Secondly, the new energy status of global airport ground handling is analyzed, and the global airports are basically undergoing the transformation of new energy ground handling. Taking Beijing Capital International Airport as an example, the paper analyzes the current new energy construction of the airport. Finally, the existing problems are put forward and the solutions are provided.

This paper studies the impact of new energy on sustainable development of ground handling, and analyzes and researches from three aspects: environment, economy and society. Then take Beijing Capital International Airport as a case study to analyze and study. Through the investigation and data comparison, the conclusion is that the new energy of airport ground handling has a positive impact on sustainable development.

This paper also analyzes and predicts the future development of airport ground handling. Based on the existing problems, the development direction of future technology and the future project plan of the airport, the development trend of the future airport ground handling is inferred.

Key words
Airport ground handling construction, Sustainable development, New energy，sustainable energy

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1 Introduction

Table 1. Overlay matrix (Peltonen 2017, 3)

Investigative questions	Theoretical framework (chapter)	Results (chapter)
1. What is the status of airport ground handling?	1	2.2
2. What are the main impacts of new energy on airport ground handling?	3	3.1-3.3
3. What is the future development trend of airport ground handling?	1	4

In the context of global climate change and increasingly severe energy crisis, sustainable energy (Hereinafter referred to as new energy)has become a key way to promote sustainable development. As an important international transportation hub, the new energy of airport ground handling can not only reduce greenhouse gas emissions, but also improve energy efficiency and promote sustainable economic and social development. Through the analysis of the current situation of the airport and the demonstration of the new energy of the airport, this paper aims to comprehensively analyze the impact of the new energy of the airport ground handling on sustainable development, and verify whether the new energy of the ground handling is a future development trend.

This paper is divided into five chapters, which are introduction, background & current situation analysis, influence, future outlook and conclusion. The introduction mainly introduces the literature review and the investigation method adopted. Background & Status analysis mainly introduces the background of airport ground handling using sustainable energy and the development status of airport ground handling sustainable energy. This paper mainly introduces the core content of this paper, the impact of airport ground handling using sustainable energy on sustainable development; The future outlook is to analyze and forecast the future development of the airport, and solve the existing problems at the same time. The conclusion is a summary of the whole paper and the results of the impact of sustainable energy on sustainable development of airport ground handling.

1.1 Background

In 2005, The Clean Airport Partnership, CAP, is working with the Broward County Aviation Department in Florida, A comprehensive plan was unveiled at a public meeting co-organized by BCAD - the Green Airport Initiative, GAI, Designed to help Fort Lauderdale-Hollywood International

Airport establish a program that guides sustainability and makes it an example of a sustainable community. This is also the first time that the concept of "green airport" has been proposed in the world. The Green Airport Initiative (GAI) focuses on seven dimensions: environmental footprint of airport operations, community gas emissions, green fuel, water saving, energy supply distribution and storage, reduction of solid and hazardous waste, and reduction of hazardous gas emissions, and gives specific suggestions for the future green development of airports (see Table 1). As the first consulting research report in the field of green airport, the Green Airport Initiative (GAI) first proposed the evaluation system of Environmental Footprint and constructed five pressure indicators and corresponding measurement methods of the quantitative evaluation system of green airport: Water Quality, Solid Waste, Air Quality, Noise and Energy Consumption, although the report content and index framework at that time seem to have obvious limitations and lag now, However, the framework of the environmental report and the observation and reflection on the green airport laid the foundation for the formulation of international standards and policies related to the green airport, which is a milestone exploration of the concept of green airport in the international civil aviation transport industry(IIGF view | Development Path and Comparative Analysis of China's Green Airports under the Background of "Dual carbon" (Part II) - International Institute of Green Finance, Central University of Finance and Economics, s.a.c)

Table 2 Outline of the Green Airport Initiative (GAI) study

Keynote Speech	Main topic
Environmental footprint of airport operations	Water quality Solid waste Air quality noise Energy (Electricity)
Community gas emission	Aircraft operation
Renewable fuel	Recycled vegetable oil
water saving	Influence index Potable water Non-potable water
Energy supply distribution and storage	Review energy bills Energy-related projects Building LEED Central energy plant Energy supply illumination heating Renewable energy and other technologies Utilization and optimization of control systems
Reduce solid and hazardous waste	Solid waste Hazardous waste
Reduce harmful gas emissions	Aircraft operation Ground support equipment operations Land transport vehicle operation

Airports Council International (ACI), the trade association for all airports worldwide, aims to strengthen cooperation between its members and the various organizations and institutions of the civil aviation industry worldwide and to promote a safe, efficient and environmentally friendly air transport system. In June 2021, the Airports Council International announced long-term carbon targets for its member airports: Member airports have committed to zero carbon emissions by 2050. In this context, the Asia-Pacific Regional Environment Committee established by Airports Council International is actively implementing the ACI Environmental Initiative: Limiting or reducing the negative environmental impacts of aviation and airports, supporting and promoting the positive economic and social benefits of aviation and airports, and consulting with international organizations on key climate change issues such as energy, waste and water management at airports. In addition, the Asia Branch of Airports Council International has set up Green Airport Certification and airport carbon emission certification to further promote the sustainable development of member airports, encourage member airports to accelerate the construction of green airports, and promote the goal of zero carbon emissions of member airports. Beijing Capital International Airport has won a silver award.(ACI Asia-Pacific Announced Green Airports Recognition 2022 s.a.a)

1.2 Significance of new energy development for airport ground handling

Aviation carbon emissions: The aviation industry accounts for about 2 to 3 percent of global CO2 emissions. It is expected that by 2050, if no action is taken, this proportion could rise to 22%.

Carbon emissions from airport operations: CO2 emissions from airport operations depend on a variety of factors, including airport size, number of flights, ground transportation and building energy consumption.

Energy consumption: The annual energy consumption of large airports can reach millions of KWH. For example, the annual energy consumption of London Heathrow Airport is about 170 million KWH.

Noise level: The noise level generated by the aircraft during takeoff and landing can reach more than 100 decibels, which is much higher than the noise level in daily life.Particulate emissions: Particulate emissions from aircraft engines can contribute to reduced air quality in areas around airports. The area around Los Angeles International Airport, for example, has twice the concentration of particulate matter as far away from the airport.

These data show that the impact of airports on the global environment is multifaceted, including carbon emissions, resource consumption, noise and air pollution. Therefore, airports and the aviation industry need to take effective measures to reduce their environmental impact in order to achieve sustainable development.

1.3 Development status of airport ground handling

At present, airports around the world are developing and implementing new energy to reduce carbon emissions, improve energy efficiency, reduce costs and other effects. According to statistics, the new energy of airport ground handling is currently from the following directions:

Technological innovation: Airports are adopting a variety of new energy technologies, such as electric ground support equipment (GSE), solar and wind power, to reduce their dependence on traditional fossil fuels. In addition, some airports are also exploring the use of hydrogen energy as ground handling.(Hileman 2020)

Infrastructure improvements: With the introduction of new energy vehicles, the airport is also building corresponding charging and refueling facilities to support the implementation of these new energy solutions. This includes the construction of a large number of charging piles and hydrogen refueling stations in the air side and land side areas.

Policy support: Organizations such as the International Air Transport Association (IATA) are working with member airlines, ground service providers, and other air transport supply chain representatives to ensure the effectiveness and efficiency of best practices and procedures for ground operations. The results of these initiatives are incorporated into the IATA Airport Handling Manual (AHM) and the IATA Ground Operations Manual (IGOM).(Ground handling operations 2023 Trends s.a.b)

Industry collaboration: The World Economic Forum, in partnership with Airports Council International (ACI) World, launched the Airport of the Future initiative to address the energy, infrastructure and financing needs of airports in the coming decades. The initiative aims to build the airport into an energy hub, placing renewable energy production at the centre of its operations in order to reduce the carbon footprint of all airport-related activities.

Swedish Airports Group focuses on noise reduction: For many years, Swedish Airports Group has been paying attention to airport noise reduction: preferential landing fees for airlines using less noisy aircraft, and more landing fees for airlines using noisier aircraft; In conjunction with the Swedish Ministry of Transport and other countries, the pilot uses a curved approach mode to avoid densely populated areas, and the aircraft continues to drop from cruising altitude to the landing strip at a constant speed, saving fuel and reducing carbon emissions. In 2023, Swedish Airports Group's Gothenburg, Malmo and Stockholm Arlanda airports achieved a total of 630 curve approaches, reducing carbon emissions by about 121 tons. In addition, during the epidemic prevention and control period, residents around the airport are used to low traffic patterns. As the air transport industry recovers after the end of the pandemic, the number of airport noise complaints has increased significantly. Around 15,000 people in the vicinity of Swedish airports are affected by aviation noise (more than 55 dB), 90% of whom live in the vicinity of Stockholm Buruma and Arlanda airports. In close communication with the communities concerned, the Swedish Airports Group soundproofed the noise sensitive buildings to minimize the impact of aircraft noise on the surrounding area.

Finnish Airports Group is developing hydrogen energy: in recent years, hydrogen energy has become one of the important solutions for the sustainable development of the aviation industry. As a leader in green airport construction, Finnairports aims to achieve net zero carbon emissions at all 20 of its airports by 2025. In order to achieve this goal, Finnairports applies a variety of low-emission technologies to local conditions, of which hydrogen solutions will mainly be applied to heavy-duty on-site vehicles, and electrification solutions will mainly be applied to small and medium-sized vehicles and equipment. At present, Finland's Helsinki Airport is testing the use of hydrogen energy as the main energy source for heavy duty vehicles, and the project has been funded by 4 million euros from the European Union. Helsinki Airport has about 20 heavy snow plows, each weighing more than 30 tons, which account for 80% of the airport's total energy consumption. The pilot project uses hydrogen-burning piston engines instead of the traditional engines of snowplows, which will significantly reduce carbon emissions. What is worth the attention of major airports is that the future development of hydrogen power equipment and even hydrogen-powered aircraft will put forward new requirements for the planning and construction of supporting facilities in hydrogen supply and storage at airports.

Construction of PV system at Changi Airport: Singapore Changi Airport Group has commissioned Singapore's Keppel Group to design, build and operate a large-scale solar PV system at the roof area of Changi Airport's terminals, terminal annex structures, flight area and cargo terminal under a 25-year contract. The system is scheduled to be completed in early 2025, and the designed annual total power generation will reach 43 MW, of which the rooftop area will generate up to 38 MW,

which will be the largest rooftop solar photovoltaic system in Singapore; The remaining 5 MW PV system will be deployed in the 40,000-square-metre grassy area of the flight zone, which will be the first time Changi Airport has built a solar PV system in the flight zone. It is estimated that the system is expected to help Changi Airport Group reduce its carbon emissions by about 20,000 tonnes per year.(Global Airport Sustainability Initiative - Beijing Capital International Airport s.a.d)

Taking Beijing Capital International Airport as an example, the ground service of the airport has accelerated the progress of new energy, and most of the equipment and facilities have been basically realized. By implementing a series of energy-saving and emission reduction measures, such as the transformation of LED light sources, promoting the use of energy-saving equipment, carrying out the "oil to electricity" project, and promoting the planning and construction of renewable energy, the Capital Airport has effectively improved its carbon emission management capacity. These efforts not only reduce the airport's carbon footprint, but also point the way for the airport's low-carbon development in the new era. These achievements and continuous efforts of the Capital Airport have made it the first "dual-carbon airport" in China's civil aviation industry to pass the three-star certification.

By the end of 2021, the Capital Airport has completed the transformation of about 127,000 LED light sources in the terminals, and eliminated 210 high-energy-consuming motors. At the same time, the Capital Airport continues to adjust and optimize the operation mode of baggage, APM, lighting and other systems, and implement the energy-saving operation mode of the baggage system, and the system energy consumption in 2021 is reduced by 21.5% compared with 2020, and the average energy consumption of a single piece of baggage is reduced by 13.9%. In addition, in 2021, according to the actual characteristics of international passenger protection, the Capital Airport has optimized the operation mode of the APM system, reducing the operating mileage by more than 400,000 kilometers, and saving about 760,000 KWH of electricity in total.

The Capital Airport has vigorously promoted the introduction of new energy vehicles on the site. By the end of 2021, new energy vehicles have increased by more than 11 times, and the electrification rate on the site has exceeded 35%. Simultaneously and actively promote the construction of charging facilities, by the end of 2021, the on-site charging pile increased by nearly 9 times compared with 2018, and the pile ratio reached 2.8:1; To promote the construction and use of APU replacement facilities, we have achieved 100% coverage of near slots and 63% coverage of far slots, and strictly implemented the principle of "full use of application", resulting in fuel savings of more than 140,000 tons since 2019. At the same time, the Capital Airport has actively established a monitoring platform for vehicles, charging facilities and APU replacement facilities, and has realized the monitoring of these equipment facilities.

The Capital Airport strictly adheres to the requirements of sewage treatment, strengthens the treatment and discharge management of wastewater from the aspects of standard discharge of wastewater and third-party testing, and actively promotes the upgrading of equipment and facilities of the purification station, constantly improves the control and treatment capacity of wastewater, achieves continuous and stable discharge standards of the purification station, and effectively reduces the discharge of pollutants. In 2021, the chemical reduction of COD and ammonia nitrogen will be 1360 tons and 145 tons respectively. At the same time, in order to improve the efficiency and recycling rate of water resources, the Capital Airport has carried out the construction planning study of sponge airport, completed the feasibility study of the West Lake Garden rainwater recycling demonstration project, and strive to achieve the whole system rainwater management.

Since 2020, in strict accordance with the relevant requirements of the Regulations on the Management of Domestic Waste in Beijing, the Capital Airport has formulated an implementation plan to streamline the placement of domestic waste, standardize the setting of barrel stations, adjust contract terms, clarify operational requirements, strengthen supervision and management, and standardize the whole process of domestic waste classification, collection, transportation, and disposal. The garbage classification coverage rate is 100%, and the garbage harmless treatment rate is 100%. In addition, the Capital Airport has carried out special plastic pollution control actions against the relevant requirements of the national, Beijing Municipal and Civil Aviation Administration at all levels, and achieved the utilization rate of degradable plastic bags in retail, catering stores and cantons in the terminal and parking buildings, the utilization rate of degradable meals/cups, straw and mixing rod is 100%, and the utilization rate of express skinny tape is 100%.(Capital Airport) How to solve this "pile" problem? - Xinhuanet s.a.e)

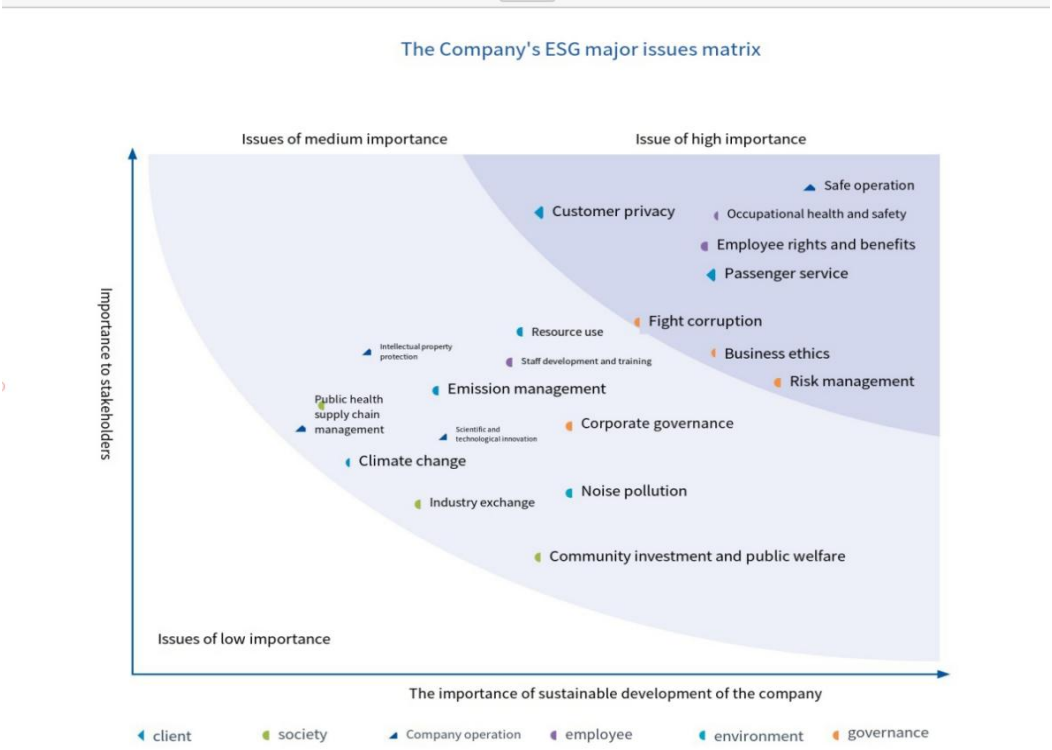

Figure 1 2022 Beijing Capital International Airport new energy plan

Table 3 Sustainable Plan of Beijing Capital International Airport

Combined energy consumption - achieved • Comprehensive energy consumption reduction rate of terminal, public area, flight area, fire rescue management center and other unit areas ≥ 1%; • Terminal comprehensive energy consumption reduction rate of not less than 4%, including lighting power consumption reduction rate of not less than 6%, elevator power consumption reduction rate of not less than 6%, office power consumption reduction rate of not less than 8%.	Efficiency of new energy facilities - achieved • Completed multi-system integration and application, Auxiliary Power Unit (APU) replacement facility monitoring System is integrated into the Airport Energy Management System (AEMS) system of the three terminals and the parent company's energy data cloud platform. • Carry out economic research on the operation of new energy vehicles, charging facilities and APU replacement facilities in the flight area, and complete the operation improvement plan.
Share of renewable energy - achieved • Implement GTC (Ground Transportation Center) daylighting belt PV Phase II construction project to achieve grid-connected power generation.	Terminal Energy Management - Agreed • Set up the terminal's classified and itemized basic energy consumption and energy efficiency data ledger, and complete monthly and quarterly operation analysis reports; • Optimize the energy-saving operation plan of the terminal under the background of the normalization of the epidemic;

	• Consolidate the metrology foundation to ensure that the terminal has been connected to the AEMS system and the data stability and accuracy of the Group's energy data cloud platform.

1.4 Existing problem

The topic of this paper is the research on the sustainable development of ground handling using sustainable energy, so there are problems focusing on the impact level.

Existing problems:

There is a lack of research on the concrete manifestation of the impact of ground service sustainable energy on sustainable development. This prevents airport management and people from all walks of life from directly understanding the important role of sustainable energy in ground handling.

(1) The impact on sustainable development can be divided into what aspects according to data analysis, and how each aspect directly affects sustainable development.

(2) At present, there is no evidence to prove the benefits and risks of airport ground handling in replacing sustainable energy equipment.

Ground handling sustainable energy equipment construction problems: Increase in the proportion of new energy vehicles: Although the proportion of new energy vehicles has increased, there is still room for improvement in the proportion of new energy in special vehicles.

Distribution and capacity of charging facilities: With the increase in the number of new energy vehicles, existing charging facilities may be insufficient, and further expansion and optimization of the layout are needed.

Promotion of APU replacement facilities: Although near-position APU replacement equipment has been fully covered, the promotion of far-position APU replacement equipment is still in the pilot stage and needs to be further promoted and improved.

The scale and efficiency of photovoltaic power generation systems: The current scale of photovoltaic power generation systems is relatively limited, and it is necessary to further improve the efficiency and stability of power generation.

Energy management level needs to be improved: At present, some airport energy supply due to the lack of interconnection, interoperability and mutual promotion of scientific management means and mechanisms, resulting in low comprehensive energy utilization, energy distribution quota, extensive measurement, management planning is not strong, loss monitoring, energy conservation without guidance and other phenomena. In recent years, large domestic airports have begun to develop and apply energy management systems for systematic and comprehensive management of airport energy, reducing energy consumption and improving energy efficiency. The construction of energy management system has become a widely accepted method, which is the basic support and quantitative assessment basis for continuously improving the level of airport energy management. Airport energy management needs to be combined with airport passenger and cargo flow operation data, meteorological data and business data, but the current situation is that China's major airports generally have several sets of independent professional energy systems, such as water supply system, high-voltage power monitoring system, refrigeration control system, low-voltage monitoring system and building BA system, etc., professional systems are less related, there are information islands.

There are many subjects of airport energy management: in the airport area, the airport management organization is the major energy management, and the types of energy management are also many; The energy volume of aviation companies is second, and the types of energy under management are also more. Aviation fuel company manages all aviation fuel, energy types are single; Air traffic control, cargo station and other units of energy volume is small, energy types are more common. Energy management units in the airport area are divided according to property rights and manage themselves, and there are different degrees of water supply, mains power supply and natural gas multi-supply, repeated applications, etc., and the unity of energy dispatch is insufficient.

Room for improvement: Accelerate the introduction and renewal of new energy vehicles: formulate more active policies and incentives to accelerate the elimination of old vehicles and introduce more efficient new energy vehicles.

Expansion and intelligent charging facilities: Add charging piles in the air side and land side areas, and introduce intelligent charging management systems to improve charging efficiency and convenience.

Fully promote APU replacement facilities: Expand the use of APU replacement facilities, especially in remote aircraft positions, to reduce fuel consumption and emissions when aircraft are operating on the ground.

Expand the scale of photovoltaic power generation systems: install photovoltaic panels on more buildings and facilities, increase the proportion of self-produced green energy at the airport, and explore the application model of "photovoltaic + energy storage + microgrid".

Improve the application of energy-saving technology: in lighting, cooling and other aspects of the use of more efficient energy-saving technology, such as LED lamps and water storage technology, further reduce energy consumption.

Through continuous efforts and innovation, Capital International Airport is expected to achieve a greener, smarter and more efficient operation model in the future, setting a new benchmark for the sustainable development of global airports.

2 Literature review & Research methods

2.1 Literature review

IIGF view | Development Paths and Comparative Analysis of China's Green Airports under the background of "Dual carbon" (Part II)

This article mainly discusses the following three points. The Green Airport concept has its roots: In 2005, the Green Airport Initiative (GAI) was first proposed by the Clean Airport Partnership, a private consulting firm in the United States to help airports establish sustainable development plans. The Green Airport Initiative evaluates airports in terms of environmental footprint, community gas emissions, green fuels, water conservation, energy supply, and waste reduction. Green Airport Status at home and abroad: The Airports Council International (ACI) has established the Green Airport Certification (GAR) to recognize airport members with outstanding achievements in different environmental topics. ACI Airport members in China have accumulated 12 Green airport certifications, including 5 platinum, 2 Gold and 5 Silver awards. Outlook and sustainable development path: Under the "14th Five-Year Plan" civil aviation development plan and the "dual carbon" policy system, the development concept of green aviation has laid an important practical foundation for the promotion and development of domestic green airports in the future through the collaborative practice of government, regulation, industry associations, enterprises and other markets.

On the construction and development of green airport

The main contents of the construction and development of green airport:

The concept and importance of green airports: Airports are an important infrastructure for the air transport system, and the scale and number of airport construction in China continue to grow rapidly. Green airport construction has become a common choice for airport development in the world, aiming to cope with resource and environmental constraints.

The concept of green airport: Green airport refers to the airport that achieves resource conservation, environmental friendliness, efficient operation and people-oriented during the whole life cycle, provides healthy and convenient space for the public, provides safe and efficient operation space for aircraft, and develops in coordination with the region.

The concept of green airport emphasizes the maximization of comprehensive benefits, including resource conservation, environmental friendliness, efficient operation and people-oriented four aspects.

Main directions of green airport construction:

Land saving and land resource utilization: scientific planning of airport land scope and scale, optimization of layout, rational development and utilization of underground space.

Energy conservation and energy utilization: Formulate an energy master plan, select energy-saving technologies, and expand the use of renewable and clean energy.

Water conservation and water utilization: Make full use of non-traditional water sources such as rainwater and intermediate water, and reduce the use of municipal water.

Outdoor environment friendly: protect the natural and ecological environment and reduce the impact of the airport on the surrounding environment.

Efficient facility operation: reasonable allocation of facilities, improve the efficiency of the use of facilities and spare parts, and extend the life cycle of facilities.

2.2 Research method

This section mainly introduces the research methods on the impact of new energy on airport ground handling. This section describes the study design and methodology and explains the data collection methods. It provides a set of criteria for testing research results to ensure that the positive impact of new energy on sustainable development of ground service is concretized.

A. Study design and methods:

Research strategy: The directional quantitative analysis was carried out by multi-angle and multi-faceted mixed method. Let readers more intuitive feel the impact of new energy brought by ground handling.

Conceptual framework: Identifies the main areas of impact (economic, environmental, social) and details (cost, carbon emissions, energy efficiency, noise, public support...) of airport ground handling enablement. It also points out how to optimize and improve the existing contradictions and problems in the future. This framework serves as the basis for this study.

Research Question: What is the impact of new energy on economy, society and environment? What measures and methods have the airport adopted to carry out new energy transformation? What are the future development trends of airports?

B. Methods of data collection:

Case study: An in-depth analysis of the use of new energy in Beijing Capital International Airport provides a detailed perspective of practical application.

Data analysis: Through the collection and analysis of ground handling data of different airports, the actual impact of new energy on airports is quantified.

Literature review: Evaluate existing research, go to gaps in knowledge in that area of research, and provide a theoretical basis for research.

Research evaluation criteria:

A. Carbon Footprint Reduction

Quantitative method: Calculate greenhouse gas emissions before and after the implementation of new energy technologies. The role is to assess the contribution of new energy sources to reducing carbon emissions from the aviation industry.

B. Energy Consumption

Quantitative method: Measures the amount of energy used by new energy technologies in airport ground handling operations compared to conventional energy sources. The role is to determine the effectiveness of new energy technologies in improving energy efficiency.

C. Cost Savings

Quantitative approach: Compare the cost differences between new energy technologies and traditional energy sources in long-term operations. The role is to analyze the impact of new energy on the sustainable development of airport economy.

D. Operational Efficiency

Quantitative approach: Assessing the performance of new energy technologies in terms of ground handling time and resource utilization. The role is to measure how new energy can optimize airport ground handling workflow.

E. Environmental Impact Assessment

Quantitative approach: Life Cycle Assessment (LCA) is used to analyze the full life cycle environmental impact of new energy technologies. The role is to fully understand the potential impacts of new energy technologies on ecosystems.

F. Social Acceptability

Quantitative method: Questionnaire was used to collect the views and satisfaction of the public and airport staff on the new energy. Its role is to assess the acceptability of new energy technologies at the societal level.

3 Research on impacts

The new energy of airport ground handling is of great significance to the sustainable development of airport. According to statistics, it can be divided into three categories: environmental, economic and social impacts. This paper studies the impact of new energy on the sustainable development of ground handling, and analyzes and researches from three aspects: environment, economy and society. The research methods were questionnaire survey, data comparison and literature summary, aiming to explore the impact of new energy on the sustainable development of airport ground handling. And take Beijing Capital International Airport as a case study for this study. The reference of research methods is mainly from IIGF view | Development Paths and Comparative Analysis of China's Green Airports under the background of "Dual carbon"(2022).

3.1 Study on environmental impact of data comparison method

By searching the annual report and official website information, we collected relevant data and made the following table for data comparison.

Take Beijing Capital International Airport as an example. Read the ESG report of Beijing Capital International Airport 2023, and calculate the environmental impact of Beijing Capital International Airport after the new energy.(Company Introduction - Beijing Capital International Airport s.a.b)

In 2022, Beijing Capital International Airport promoted energy management in an orderly manner, compiled the "Airport Distributed Photovoltaic Construction Planning Plan Report" and the "Energy Utilization Status Report in 2021", and successfully completed the energy conservation assessment and inspection work of units at all levels. At the same time, the company participated in the "Double carbon Airport" evaluation activities organized by the China Civil Airports Association, becoming the first airport to obtain the three-star "double carbon airport" level evaluation. In addition, the company scientifically adjusts the terminal operation strategy, under the premise of ensuring the indoor comfort of the terminal, flexibly controls the heating time according to the characteristics of the terminal building and the actual situation of the passenger's body temperature, closely monitors the changes in the external environment temperature, and carries out regional cooling services to effectively reduce energy consumption and reduce energy costs.

Table 4 The popularity of new energy vehicles for ground handling

In 2022,	
The company purchased new energy vehicles	Investment treaty
9 cars	2.97 million yuan
By the end of 2022, the company will have a total of new energy vehicles in the flight area	The proportion of new energy vehicles in the field is
1,401 units	38.5% Further increase from 2021

Carbon emissions and overall energy consumption:

It can be clearly seen that with the promotion of new energy at Beijing Capital International Airport, energy consumption and carbon emissions have significantly improved.

Table 5 Key performance indicators of Beijing Capital International Airport Ⅰ

Key performance indicators	2021	2022
Passenger throughput (10,000 passengers)	3,264	1,270.33
Passenger complaint handling rate	100	100
Greenhouse gas (Carbon dioxide) Emissions (Category 1) (tonnes of carbon dioxide equivalent)	798.42	776.88
Greenhouse gas (carbon dioxide) Emissions (Category 2) (tonnes of carbon dioxide equivalent)	356,886.60	335,505.01
Total greenhouse gas (carbon dioxide) emissions (tons of carbon dioxide equivalent)	357,685.02	336,281.89
Greenhouse gas (carbon dioxide) emission density (tons of carbon dioxide equivalent / 10,000 people)	109.55	264.72
Comprehensive energy consumption (tons of standard coal)	80,524.75	75,819.66
Comprehensive energy consumption density (tons of standard coal / 10,000 people)	24.66	59.68
Renewable energy usage (KWH)	748,217	1,012,099.5
Purchased electricity consumption (KWH)	184,985,114.39	178,153,289.36
Gasoline consumption (tons)	118.88	106.58
Diesel fuel consumption (tons)	143.39	150.24
Heat consumption purchased(J)	1,682,480.18	1,570,348.56
Purchased power consumption density (KWH / 10,000 person-times)	56,658.74	140,241.28

Gasoline consumption density (kg / 10,000 person-time)	36.41	83.90
Diesel consumption density (kg / 10,000 person-time)	43.92	118.27
Purchased heat consumption density (J / 10,000 person-times)	515.31	1,236.17
Water consumption (tons)	946,132.00	714,592
Water consumption density (tons / 10,000 person-times)	289.79	562.52
Sewage treatment capacity (10,000 tons)	618.83	542.58

Table 6 Key performance indicators of Beijing Capital International Airport Ⅱ

key performance indicators		2021	2022
COD reduction (tons)		1,360	1,011.6
Reduction of ammonia nitrogen (tons)		145	92.4
Total hazardous waste (tons)		1,375.92	1,857.59
Hazardous waste emission density (tons / 10,000 person-times)		0.42	1.46
Domestic waste (tons)		22,000	10,937
Aviation waste (excluding hazardous waste) discharge (tons)		7,658	3,034
Total amount of non-hazardous waste (tons)		29,658	13,971
Emission density of non-hazardous waste (tons / 10,000 person-times)		9.08	11.00
Number of employees (persons)		1,567	1,542
Number of ethnic minority employees (persons)		87	83
Labor contract signing rate (%)		100	100
Number of employees by type of employee	Contract employee (person)	1,567	1,542
	Labor dispatch and others	0	0
The number of employees by rank	Senior management	8	7
	Middle level staff	65	67
	Ordinary employee (person)	1,494	1,468

Number of employees by gender(including senior management)	Male employee (person)	1,059	1,035
	Female employee (person)	508	507

Table 7 Energy use of Beijing Capital International Airport 2021-2023

Key performance indicators	2021	2022	2023
Comprehensive energy consumption (tons of standard coal)	80,524.75	75,819.66	57,539.52
Comprehensive energy consumption density (tons of standard coal / 10,000 people)	24.66	59.68	10.88
Purchased electricity consumption (KWH	184,985,114.39	178,153,289.36	209,998,733.85
Gasoline consumption (tons)	118.88	106.58	97.04
Diesel fuel consumption (tons)	143.39	150.24	145.12
Outsourced heat consumption （J）	1,682,480.18	1,570,348.56	919,591.06
Intensity of purchased power consumption (KWH / 10,000 person-times)	56,658.74	140,241.28	39,712.95
Gasoline consumption density (kg / 10,000 passengers)	36.41	83.90	18.35
Diesel consumption density (kg / 10,000 passengers)	43.92	118.27	27.44
Purchased heat consumption density (gigajou / 10,000 person-times)	515.31	1,236.17	173.90
Renewable energy usage (KWH)	748,217.0	1,012,099.5	1,213,910.0

In 2022, Beijing Capital International Airport detected that the noise released by the airport was lower than that in 2021.

Noise monitoring points will be set up in 2022	Fixed monitoring station	Mobile monitoring site
twenty-two	twenty	two

3.2 Study on the economic impact of data comparison method

Take Beijing Capital International Airport as an example. Consult the annual financial report of Beijing Capital International Airport 2022, and calculate the impact of ground handling new energy on the economic level of Beijing Capital International Airport(About us - Beijing Capital International Airport s.a.b)

Overall financial summary of Beijing Capital International Airport: Due to the impact of the epidemic, the aviation industry as a whole has shown a downward economic situation. In 2022, China's civil aviation transport production faced great challenges, the main business volume of Beijing Capital Airport decreased significantly year-on-year, and the total number of aircraft takeoff and landing sorties in the year was 157,630, a decrease of about 47.1% compared with the previous year; Passenger throughput totaled 12,703,342 passengers, a decrease of approximately 61.1% from the previous year; The total cargo throughput of 988,675 tonnes was about 29.4% lower than the previous year. Under the impact of multiple factors, the company's annual main business income decreased significantly, to 2,230,948,000 yuan, about 33.3% less than the previous year. Among them, revenue from aviation business was RMB710,728,000, a decrease of approximately 47.1% from the previous year; Revenue from non-aviation operations was RMB1,520,220,000, a decrease of approximately 24.1% from the previous year. The airline industry as a whole is facing great challenges, and in this report, the entire industry is showing a loss.

Table 8 Financial highlights

(Other than (loss)/profit per share, the remaining units are RMB thousand)

	2023	2022	2021	2020	2019
Income	**4,558,524**	2,230,948	3,344,709	3,587,136	10,810,484
(loss) before sales/profit before tax/profit	**135,845**	(2,203,223)	(1,027,944)	(1,107,898)	4,789,354
taxes	**(1,718,685)**	(4,002,135)	(2,820,414)	(2,710,120)	3,229,333
After tax (loss)/profit	**21,897**	475,500	703,877	675,469	(809,960)
Claimed:Equity holders of the Company	**(1,696,788)**	(3,526,635)	(2,116,537)	(2,034,651)	2,419,373
Non-controlling interest	**–**	–	–	–	–
(loss)/earnings per share - Basic and diluted	**(0.37)**	(0.77)	(0.46)	(0.44)	0.55
(RMB Yuan) return on equity	**-11.40%**		-10.49%		
Financial condition					
Noncurrent assets		30,715,998	31,527,881	31,727,442	31,361,320
Current assets	**29,573,683**	2,767,402	3,619,455	3,695,474	3,383,099
	3,015,656				
Total	**32,589,339**	33,483,400	35,147,336	35,422,916	34,744,419
Equity and liabilities					
stockholders' equity	**14,887,803**	16,604,920	20,174,808	22,238,234	24,960,898
Non-controlling interest	**–**	–	–	–	–
Non-current liability	**4,206,084**	2,088,940	6,065,881	3,587,927	2,733,264
Current liabilities	**13,495,452**	14,789,540	8,906,647	9,596,755	7,050,257

Table 9 Comprehensive income statement

	2023 (1000RMB)	2022 (1000RMB
Income		
Aviation service	**2,096,878**	710,728
Non-aviation business	**2,461,646**	1,520,220
	4,558,524	2,230,948
	(1,549,544)	(1,553,463)
Business expense	**(923,303)**	(894,261)
Depreciation and amortization	**(905,762)**	(919,371)
Repair and maintenance	**(561,296)**	(530,520)
Aviation safety and security costs	**(484,271)**	(506,526)
Staff cost	**(441,216)**	(426,778)
Hydroelectric power	**(337,850)**	(133,743)
Running service charge	**(259,729)**	(284,981)
Management fee for franchising greening and sanitation	**(227,196)**	(236,435)
Real estate tax and other taxes and other	**(222,842)**	(302,666)
	(5,913,009)	(5,788,744)
Impairment loss on financial assets	**(56,379)**	(105,468)
Inventory falling price reserves	**(4,133)**	–
Other income	**4,201**	5,688
Other loss	**(1,809)**	–
Operating loss	**(1,412,605)**	(3,657,576)
financial income	**19,956**	22,952
financial costs	**(331,289)**	(367,511)
	(311,333)	(344,559)
Share of after-tax profits of associates	**5,253**	–
Loss before income tax	**(1,718,685)**	(4,002,135)

3.3 Research on the social impact of questionnaire survey

The impact of new energy on the social level of Beijing Capital International Airport ground handling is mainly reflected in the awards won in recent years:

"Green Airport Recognition" Silver Award 2022: Capital Airport won the Silver Award in the "Green Airport Recognition" project announced by ACI Asia-Pacific in 2022, which is recognition of the importance and implementation of green development at Capital Airport.

Three-star "Double Carbon Airport" title: With its excellent energy conservation and emission reduction management achievements, Capital International Airport won the title of three-star "Double carbon Airport" in 2022, becoming one of the first airports to pass the three-star certification of "double carbon Airport" in Civil Aviation of China.

Climate Leader: Capital Airport has been named a "Climate Leader" by the China Council for Energy Efficient Economy for its remarkable achievements in energy conservation and emission reduction, the first airport in the civil aviation industry to receive this honor.

These awards prove that Beijing Capital International Airport has won the support of the government and the local people, demonstrating that the new energy of the airport ground service has brought positive impact on the social level.

In order to investigate the views of the surrounding people on the use of sustainable energy at Beijing Capital International Airport, we conducted the following questionnaire

Q1: Do you support the promotion of new energy in ground handling at Beijing Capital Airport?

A. [ ] Yes

B. [ ] No

Q2: What impact do you think the application of new energy in ground handling has on the environment?

A. [ ] Has a positive impact, reducing pollution and carbon emissions

B. [ ] There is no obvious effect

C. [ ] Not sure

Q3: Are you willing to pay a higher fee to support the new energy transition of Capital Airport ground handling?

A. [ ] Yes

B. [ ] No

C. [ ] It depends

Q4: Are you satisfied with the Capital Airport's efforts in new energy?

A. [ ] Very satisfied

B. [ ] Satisfied

C. [ ] In general

D. [ ] Not satisfied

E. [ ] Very dissatisfied

200 copies of this questionnaire were distributed, and the following statistical chart is the result.

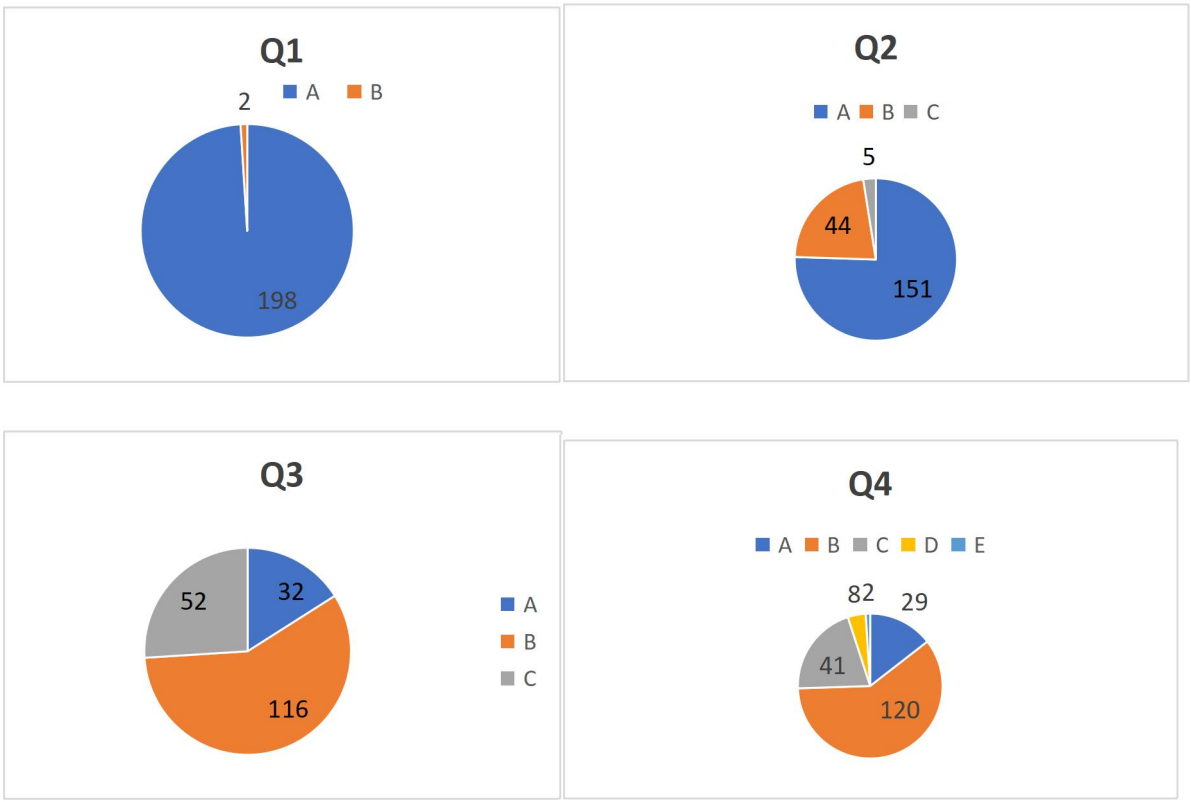

Figure 2 Pie chart results of the questionnaire

4 Results and discussion

4.1 Discuss the impact of new energy on the environment - based on 3.1

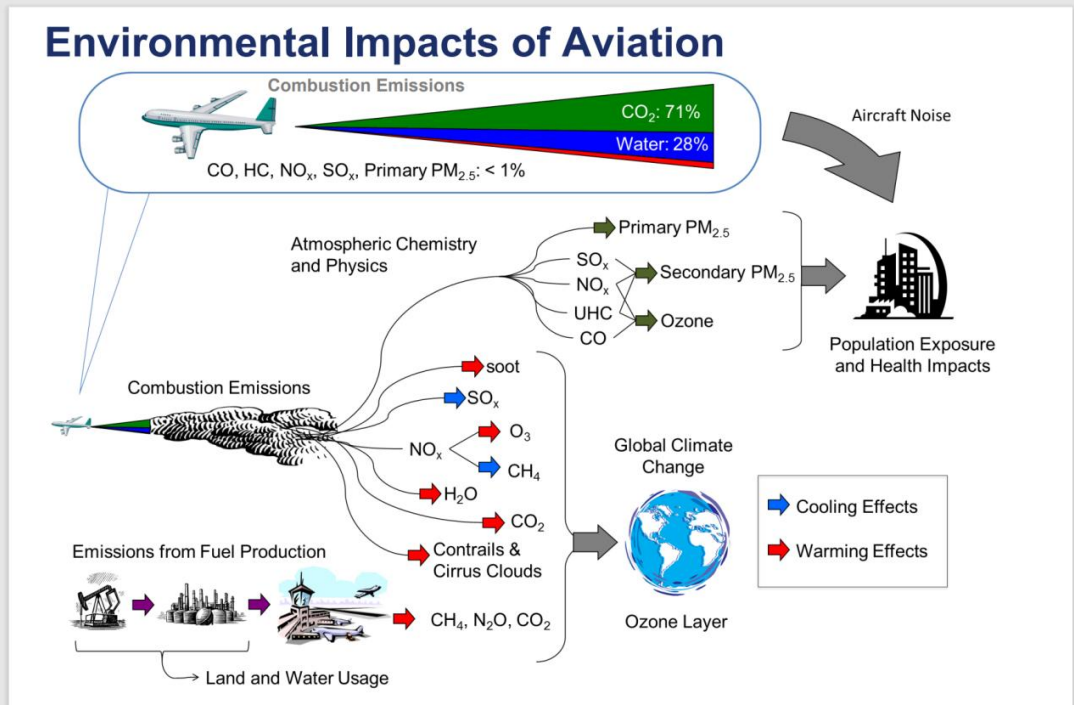

Figure 2 Environmental Impacts of Aviation

The environmental impact is specifically reduced carbon emissions, reduced noise, and improved energy efficiency. New energy equipment uses clean energy: Electric ground handling vehicles and equipment use electricity, which is a clean energy source that produces no direct carbon emissions. High energy conversion efficiency: Electric devices directly convert electrical energy into mechanical energy, with less energy loss in the conversion process, which is more efficient than the process of burning fossil fuels in internal combustion engines. Quieter operation of electric equipment: Electric ground handling vehicles and equipment produce much less noise when operating than vehicles with internal combustion engines, thus reducing noise pollution.

The main factor contributing to these effects is the different working principles of the motor and the internal combustion engine.

The working principle of internal combustion engine is based on the principle of thermodynamics and combustion chemistry, converting the chemical energy of fuel into mechanical energy to drive various mechanical equipment. The internal combustion engine focuses on combustion, converting chemical energy into heat and, ultimately, into mechanical energy. During the explosion, there is a

loss of energy and noise generation. Therefore, the traditional energy work produces a waste of resources, low energy efficiency and loud noise.

The working principle of the motor is based on the interaction involving electric currents, magnetic fields and forces that allow the motor to rotate. The motor is directly converted from electrical energy to mechanical energy, with clean energy, high energy efficiency and low noise.

Table 10 Comparison of internal combustion engine and motor

Feature	Internal Combustion Engine	Electric Motor
Working Principle	Burns fuel to produce high-temperature, high-pressure gas, which is converted into mechanical energy	Converts electrical energy into mechanical energy
Emissions and Pollution	Produces exhaust gases, polluting the environment	Zero emissions, environmentally friendly
Noise	Generates significant noise	Low noise level
Fuel Portability	Fuel is easy to carry, suitable for long-distance travel	Electric energy is not easily portable, limited driving range
Control and Complexity	Complex structure and control requirements	Relatively simple structure and control
Efficiency	Efficiency affected by speed and torque	High efficiency, especially across the entire operating range
Application Areas	Used in transportation, power generation, etc.	Suitable for small vehicles, electric tools, home appliances

By comparing the ESG report of Beijing Capital International Airport in 2023 and the above data information, from the above energy data, it can be seen that in 2021-2022, Beijing Capital International Airport will reduce carbon dioxide emissions, consume less gasoline, consume less diesel, and purchase more electricity. The analysis shows that the main reason is the use of sustainable energy, and the specific environmental impact can be calculated by the following calculation.

The first thing we need to do is figure out how to calculate carbon emissions

Formula: Carbon dioxide emissions per ton of fuel combustion * Consumption (tons) = total carbon dioxide emissions

Under standard conditions, each ton of gasoline combustion produces about 3.19 tons of carbon dioxide, and each ton of diesel combustion produces about 3.12 tons of carbon dioxide

According to the calculation:

Co2 emissions from Beijing Capital International Airport in 2021:379.23 tons from gasoline combustion (3.19*118.88=379.23) and 447.38 tons from diesel combustion (3.12*143.39=447.38).

Co2 emissions from Beijing Capital International Airport in 2022:339.99 tons from gasoline combustion (3.19*106.58=339.99) and 468.74 tons from diesel combustion (3.12*150.24=468.74)

2021-2022 from the above seems to have an increase in diesel, but in fact this is due to the increase in passenger traffic. It can be seen that in 2022-2023, gasoline consumption density and diesel consumption density are both greatly reduced. This also reflects the use of sustainable energy at the airport, reducing the use of traditional energy and significantly reducing carbon emissions. In terms of the environment, ground sustainable energy has a positive impact.

4.2 Discuss the impact of new energy on the economy - based on 3.2

Positive impact:

The positive impact of new energy on the economy of ground handling lies in cost effectiveness and job opportunities. New energy is renewable, and the purchase and maintenance costs of new energy equipment and the failure rate are much lower than traditional energy and equipment. The cost will be much lower than traditional energy sources. At the same time, the introduction of new energy provides more employment opportunities. For example, the installation of charging facilities, solar panels, new energy vehicles and so on. To technical personnel, production personnel, logistics personnel, training personnel has brought a large number of positions.

There are two main reasons for the positive effect. The first is the new energy equipment itself. At present, airport ground handling is the use of electric energy equipment as new energy equipment. Simple structure of the motor: the structure of the motor is relatively simple, without complex combustion process and lubrication system. This reduces the probability of failure; Fewer moving parts: Motors typically have only a few moving parts, such as rotors and bearings. In contrast, internal combustion engines have more moving parts, such as pistons, connecting rods, crankshafts, etc., which are prone to wear and failure. No combustion process: The motor does not need to burn fuel, so there are no sparks, explosions and high temperatures, reducing the risk of failure. Easy maintenance: the motor usually does not need frequent maintenance, no need to replace the oil, cleaning the filter element, etc. This reduces the likelihood of failure. (Assuming that the electric motor and the internal combustion engine have sufficient energy supply and do not consider the advantages and disadvantages of the energy supply method, only compare the power output effect, the same volume of the internal combustion engine and the electric motor who is

stronger? - Zhihu s.a.e). And electricity is easier to obtain than other mainstream energy sources (thermal power, hydropower, wind power, nuclear power, photovoltaic power...). Low cost, not affected by fuel price fluctuations. The second is that replacing traditional energy equipment will bring more opportunities to businesses and individuals. Technological innovation and maintenance: The introduction of new energy technologies requires professionals to install, commission, maintain and repair, and these technical positions provide new opportunities for the job market. The maintenance of electric ground handling vehicles and charging facilities requires professional electrical engineers and technicians. Production and manufacturing: The manufacturing and production of new energy equipment requires a large number of labor, including engineers, technicians, assembly workers, etc. The production of batteries, motors, electronic control systems, etc., requires professional manufacturing personnel. It also provides more economic opportunities for upstream suppliers. Supply chain and logistics: The supply chain and logistics management of new energy equipment requires a lot of human resources, including procurement, warehousing, transportation, etc. The procurement and distribution of batteries, motors, charging equipment, etc., require professional supply chain managers. Training and education: New energy requires the training of existing ground staff in new technologies and operating methods, and trainers, educational institutions and training centers will provide more opportunities for the job market.

Negative impact:

The new energy of airport ground handling has a great change in the overall layout of airport ground handling facilities, so there is also the possibility of negative impact. The following is the analysis of the possibility of negative impact.

High initial investment costs: the introduction of new energy technologies and the construction of infrastructure require large initial investments. This could add to the financial burden for airport operators, especially for smaller airports that are less well-funded. Technology update and maintenance costs: New energy equipment and technologies usually require professional maintenance and regular updates. This can lead to an increase in operating costs, especially when technology iteration is rapid. Training and transition costs: Existing employees may need to undergo new training to adapt to new energy technologies, resulting in additional training costs. At the same time, inefficiencies may arise during the transition. Instability of energy supply: New energy sources such as solar and wind energy are greatly affected by weather and seasons, which may lead to instability of energy supply, thus affecting the normal operation of airport ground handling. Alternative energy dependence: In the case of new energy sources that are not fully mature or widespread, airports may need to rely on alternative energy sources, which may lead to

uncertainty about energy costs. The social impact of the economic transformation: The new energy may lead to the disappearance of certain traditional jobs, which will have an impact on the job market, especially in regions that rely on the traditional energy sector.

Through the above table of Beijing Capital International Airport, it is found that the aviation industry economy has been severely hit by the impact of the novel coronavirus epidemic, and so has Beijing Capital International Airport. From 2019 to 2020, the revenue of Beijing Capital International Airport showed a precipitous decline, from 10,810,484(thousand yuan) to 3,587,136 (thousand yuan); Revenue will pick up in 2021-2023. In fact, in addition to the gradual lifting of the impact of the epidemic, another important reason for the recovery of Beijing International Capital Airport revenue is the use of sustainable energy.

The hydroelectric power generation cost of Beijing Capital International Airport in 2022 is 133,743 (thousand yuan), and the cost in 2023 is 337,850 (thousand yuan), an increase of about 2.5 times, which is due to the increase in the use of new energy for airport ground handling. In addition to this increase in costs, other costs can be seen to be reduced, and maintenance costs have been reduced. Revenue in 2023 is twice that of 2022. It can be argued that the cost of Beijing Capital International Airport has been significantly reduced after increasing the use of sustainable energy. The economic impact of sustainable energy on airport ground handling is positive.

4.3 Discuss the impact of new energy on society -- based on 3.3

The impact of new energy on the society of airport ground handling is mainly as follows:

Public health improvement: New energy can help reduce the air pollution generated in airport operations, especially the emission of carbon dioxide and other greenhouse gases. This has a positive effect on improving air quality in the surrounding area and reducing respiratory diseases and other health problems.

Environmental protection awareness: With the application and promotion of new energy technologies, the public's awareness of environmental protection and sustainable development will be enhanced. This increase in awareness can contribute to more environmentally friendly patterns of social behavior and consumption habits.

Policy and regulatory support: The government may support the transformation of airport ground handling into new energy by formulating relevant policies and regulations, such as providing

financial subsidies, tax incentives and other measures. These policies not only promote the development of new energy technologies, but also reflect the support and expectations of the society for green and low-carbon development.

Social responsibility and image enhancement: As a public facility, the airport's efforts in new energy can enhance its social responsibility and public image. This positive image helps increase public trust and support for the airport.

According to the obtained poll results, we can draw the following conclusions:

High support rate: Most respondents support the Capital Airport to promote the use of new energy in ground handling.

Environmental impact recognition: Respondents generally believe that the application of new energy in ground handling work has a positive impact on the environment, reducing pollution and carbon emissions.

Cost issue: Most respondents are not willing to pay higher fees to support the new energy transformation of the ground service of the Capital Airport.

High satisfaction: Respondents are satisfied with the Capital Airport's efforts in new energy.

Demonstrate that the use of sustainable energy on the ground has a positive impact on society.

5 Future expectations

According to the research, the sustainable energy on the ground has a positive impact on the environment, economy and society. Therefore, in the future, more emphasis should be placed on the development of sustainable energy for ground handling.The new energy of airport ground handling is being carried out in all airports around the world. At present, it is affected by the development situation of airports, international economic forms, existing technical means, international and national laws and policies. The future development trend is divided into the following directions.

（1）The theoretical system and standards need to be further improved: The theoretical system and standard system of green airport are still in their infancy. For example, the evaluation theories, methods and standards of green airport, green terminal and green flight area have not yet been established. Compared with other industries (such as hospital buildings, industrial buildings) and the need to better guide the construction of green airport, they are lagging behind and need to be accelerated.

（2）Application of new energy technologies: The airport is exploring and applying various new energy technologies, such as electric ground support equipment (GSE), solar and wind power, to reduce dependence on traditional fossil fuels.

（3）Exploration of hydrogen energy: Some airports are beginning to consider using hydrogen energy as an energy source for ground operations, which can help further reduce carbon emissions.

（4）Infrastructure improvements: With the introduction of new energy vehicles, the airport is also building corresponding charging and refueling facilities to support the implementation of these new energy solutions.

（5）The transformation of energy hubs: Airports are not just transit points for passengers and cargo, they are also becoming energy hubs, reducing the carbon footprint of all airport-related activities by building a unique airport ecosystem that puts renewable energy production at the center of operations.

（6）International Cooperation and Standards development: Organizations such as the International Air Transport Association (IATA) are working with member airlines, ground service providers, and other representatives of the air transport supply chain to ensure the effectiveness and efficiency of best practices and procedures for ground operations.

（7）Drivers of economic growth: The airport as an economic hub, its development as an energy hub is likely to promote economic growth and diversification, create green jobs, and provide industrialization and educational machinery around these green energy areas

6 Conclusion

Through the analysis of the current situation of airport development and the study of the impact of sustainable energy sources on airport ground handling, through the analysis of data and the verification of cases. The new energy of airport ground handling reduces carbon emissions, improves energy efficiency, reduces costs, improves the airport economy, and enhances the airport's social impact. All kinds of positive effects, we can know: airport ground handling new energy impact on sustainable development of more advantages than disadvantages, will be the inevitable trend of airport development in the future. With the further development and improvement of new energy, the airport will achieve the goal of completely new energy facilities and zero carbon emissions in the future.

The purpose of this paper is to study the impact of using sustainable energy for airport ground handling. Through the study, it is found that the sustainable energy of airport ground handling does have a positive impact on sustainable development. This result will become an important basis for the implementation and development of ground handling sustainable energy at airports. Of course, there are problems along the way, such as technological maturity, cost effectiveness, the construction of charging infrastructure, and compatibility with existing systems. As for the solution to the problem, I got the answer by visiting the airport, looking up information and doing questionnaire survey. In this process, it is also found that the future development trend of sustainable energy for airport ground handling is to gradually improve the existing problems, expand the scale, and eventually replace traditional energy. Eventually, I learned how to fully understand and research a project, which is very helpful to me

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