

Highlighted Projects on Emission Reduction in the Transportation Sector in Chinese Taipei

**Ministry of Transportation and
Communications, R.O.C.
June 2022**

Outline

Highlights of Emission Reduction in Transportation Sector in Chinese Taipei	1
I. City Bus Electrification	2
II. Hualien-Taitung Double-Track Railway Electrification	4
III. Development of the Intelligent Transportation System (ITS) in Chinese Taipei	6
IV. Mobility as a Service (MaaS)	13
V. Green Airports.....	17
VI. Green Ports	24
References	26

Highlights of Emission Reduction in Transportation Sector in Chinese Taipei

In view of the fact that climate change caused by man-made greenhouse gas (GHG) emissions has a significant impact on the world development, the government of Chinese Taipei introduced the “Greenhouse Gas Reduction and Management Act” in 2015, with the aim of promoting emission reduction tasks, which are carried out in different stages, each stage on a five-year basis. The first stage was from 2016 to 2020, and each sector was given periodic regulatory goals ^[1] in emission reduction. The goal for the transportation sector was that the net GHG emissions in 2020 had to be 2% lower than the amount of emissions in 2005, which means the GHG emissions from the transportation sector should be no more than 37.211 million metric tons of carbon dioxide equivalent (CO₂e). In addition, the total GHG emissions generated by transportation sector from 2016 to 2020 should not exceed 189.663 million metric tons of CO₂e.

In order to achieve the aforementioned regulatory goals, there are three emission reduction strategies brought up in the transportation sector, which are: (1) further develop the public transportation systems and better manage the demand for transportation, (2) construct a green transportation network, promote the use of low-carbon vehicles, and set up a green vehicle oriented environment, and (3) enhance energy efficiency of the transportation systems. The action plans for reducing carbon emission were formulated by several central government departments, including the Ministry of Transportation and Communications (MOTC), the Environmental Protection Administration (EPA), the Ministry of Economic Affairs (MOEA), and the Directorate-General of Budget, Accounting and Statistics (DGBAS). With the efforts put, the total GHG emissions in the transportation sector in Chinese Taipei from 2016 to 2020 was 187.04 million metric tons of CO₂e, lower than the target of 189.663 million metric tons, and therefore the transportation sector met the periodic goal of the first stage. One main factor that helped reduce the GHG emissions was the significant growth of public transportation from 2016 to 2019, including the public highway transportation, Chinese Taipei Railway, High Speed Rail and the Mass Rapid Transit (MRT), which reduced the usage of private vehicles to a great extent and resulted in the reduction of GHG emissions in the transportation sector.

In recent years, the transportation sector has achieved fruitful results in reducing carbon

emissions due to city bus electrification, Hualien-Taitung Double-Track Railway electrification, Intelligent Transportation System (ITS), Kaohsiung Mobility-as-a-Service (MaaS), green airports and green ports. Each will be explained in this report as follows.

I. City Bus Electrification

In December 2017, Chinese Taipei proclaimed the goal of “full electrification of city buses by 2030”. To achieve the goal, the MOTC put forward a 3-stage action plan: 1. pilot stage (2020-2022, with 400 electric buses added into operation every year), 2. promotion stage (2023-2026, with 900 added every year), and 3. popularization period (2027-2030, with 1250 added every year). Since electric buses do not emit greenhouse gases, if excluding the emissions from generating the electricity to supply power to the buses in the calculation, it is estimated that the use of electric city buses could help reduce 548,000 metric tons of CO₂ emissions every year.

As the electric vehicles technology was not as mature, problems were encountered for electric buses, such as poor battery life and short battery lifespan. This resulted in a low level of willingness among the Chinese Taipei bus operators to replace their buses with electric ones. Most of them chose to wait and see how the technology was to be developed, which led to the delayed process of bus electrification. In order to speed up the process of city bus electrification, three implementation stages were put forward. The first stage is pilot stage, which is to check and deploy the charging infrastructure, as well as to assess the EV environment to find the suitable bus models that can be implemented nationwide. The second stage is promotion stage, which is to confirm the bus models, expand the operation scale, continue to deploy the infrastructure, and help develop sectors that are crucial to the electric buses in Chinese Taipei. The third stage is popularization stage, which is to, with the matured technology and products, implement the electric buses at a full scale and export electric bus related products to the international markets.

In addition, two subsidy programs have been proposed in order to encourage bus operators to adopt electric buses:

1. General Program: According to the amended “MOTC Guidelines for Highway Public Transportation Electric Bus Subsidization”^[2], promulgated by the MOTC

on July, 29, 2019, the General Program provides subsidies of, at its most, up to NTD3,338,000 per vehicle for buying eligible electric buses. From 2019 to October 18, 2021, this program subsidized on a total of 558 vehicles, with 73 in 2019, 300 in 2020, and 185 in 2021 respectively.

2. Demonstration Program: In order to encourage the development of the local electric bus industry, the MOTC promulgated the amendments of the “MOTC Guidelines for Electric Bus Demonstration Project Subsidization”^[3] on November 16, 2020. Some higher subsidy amounts are provided to incentivize the local electric bus manufacturers to increase the production of electric buses and to ensure the operation quality of electric buses. The subsidy was to encourage local electric bus manufacturers to cooperate with bus operators and local governments to provide more outstanding electric buses. The criteria of the subsidy included the performance of the vehicles, maintenance systems, and the level of localization for essential technologies. On February 1, 2021, RAC Electric Vehicles Inc. and Master Transportation Bus Manufacturing Ltd. were selected to receive the subsidy. In addition, in the same year, 5 cities were selected for the Demonstration Program subsidy, and a total of 134 electric buses were subsidized. As of April 2022, there are 956 electric city buses in operation in Chinese Taipei.

II. Hualien-Taitung Double-Track Railway Electrification

In the early days, due to the low ridership and less economic activities along the east coast, diesel-powered trains were used between Hualien and Taitung, cities located in the middle and southern area of eastern Chinese Taipei respectively. As that time, trains coming from western Chinese Taipei had to switch to the diesel locomotive in the designated station before entering the east, and sometimes the passengers even had to transfer to another train, which caused a lot of inconvenience to the passengers. Starting from 2008, electrification for the Hualien-Taitung Line was progressively carried out. Such electrification was completed in 2018 and so was the improvement for the bottleneck sections of the line, which significantly helped speed up the train from 110km/hr to 130km/hr. With the travel time shortened, transportation efficiency was increased, and the quality of service was greatly improved. Additionally, air pollution, CO₂ emissions and noise pollution were also reduced along the line, and the road traffic was alleviated due to less private vehicles being driven. The completion of the Hualien-Taitung line has not only contributed to the sustainable development of eastern Chinese Taipei but also improved the quality for tourism and boosted the economic development in Hualien and Taitung.

While the railway electrification in eastern Chinese Taipei was underway, problems of the bottleneck sections were also solved to enhance transportation efficiency. The practices included building dual tracks in the bottleneck sections, and constructing tunnels and bridges to straighten the routes.

Ever since the route upgraded under the “Hualien-Taitung Double-Track Railway Electrification Project” opened to traffic in 2014, electrified trains have been progressively used to replace the old diesel trains. Currently, the electrified trains account for 80% of the total fleet operated on the Hualien-Taitung route. The train car replacement is expected to be completed in two years, achieving the goal of power unification. Figure 1 and Figure 2 show the diesel and electrified trains running along the Hualien-Taitung Line.



Figure 1. Diesel trains runs along the Hualien-Taitung Line

Note: Diesel trains commenced operation in Hualien and Taitung in 1968, substantively shortening the travel time between the two places. The diesel trains were decommissioned following the electrification in 2014.

Source: Chinese Taipei Railway, *TR News* Vol. 9, Summer Issue, June 2016^[4]



Figure 2. The electrified Puyuma Express runs along the Hualien-Taitung Line

Note: The Puyuma Express is streamlined and runs much faster, greatly improving the transportation quality in eastern Chinese Taipei.

Source: Chinese Taipei Railway, *TR News* Vol. 9, Summer June 2016^[4]

III. Development of the Intelligent Transportation System (ITS) in Chinese Taipei

The focus for developing intelligent transportation has been transitioned from system implementation to the integrated intelligent transportation service. Services such as real-time traffic information, seamless and integrated public transportation services, Internet of Vehicles, application of unmanned vehicles have become the current focus for intelligent transportation. The following introduces the overall framework for the development of Chinese Taipei 's intelligent transportation and explains the promotion projects along with details on emission reduction and the key results.

1. The Development Framework of “The 2020 Transportation Policy White Paper (Set) -Vol.6 Intelligent Transportation”

The technology of 5G and the high-speed transmission environment that 5G provides, along with Internet of Things (IoT), cloud computing, big data analysis, have opened infinite possibilities for the development and expansion of transportation services. Moreover, the promotion of demonstration projects, the establishment of demonstration fields and the concept of the regulatory sandbox have also provided a robust environment to develop innovative technologies and new services. The information exchanges in the transportation technology industry also facilitate the upgrade, innovation, and transformation of the industry.

The core concept of the “The 2020 Transportation Policy White Paper (Set) -Vol.6 Intelligent Transportation”^[5] is a “smart innovation”. Its vision is to establish human-oriented and sustainable environment for intelligent transportation, to further achieve road safety, smooth traffic and seamless transportation services, and to boost industrial development. Figure 3 shows the framework of promoting intelligent transportation services in Chinese Taipei. The related measures are illustrated as below.

1. Develop big data analysis and adjust governing regulations to have a robust foundation for the intelligent transportation application. Methods include the promoting data convergence, using open data, conducting big data analysis on related applications, adjusting governing regulations, and improving infrastructure for innovative applications.

2. Combine the emerging industries, and innovate to improve intelligent transportation services, such as promoting MaaS and the Integrated Traffic Corridor Management (ICM), developing the collaborative Intelligent Transportation System (ITS), developing tests and services for the unmanned vehicles, and using artificial intelligence on related applications.
3. Use the information and communications technology to expand the intelligent transportation services, such as building intelligent airports, optimizing information service systems, building smart ports and smart railways.
4. Strengthen the partnership between the public and private sectors to further develop the transportation technology industry. Methods include strengthening competitive advantages in the industry, improving test environments, and providing space for innovation.

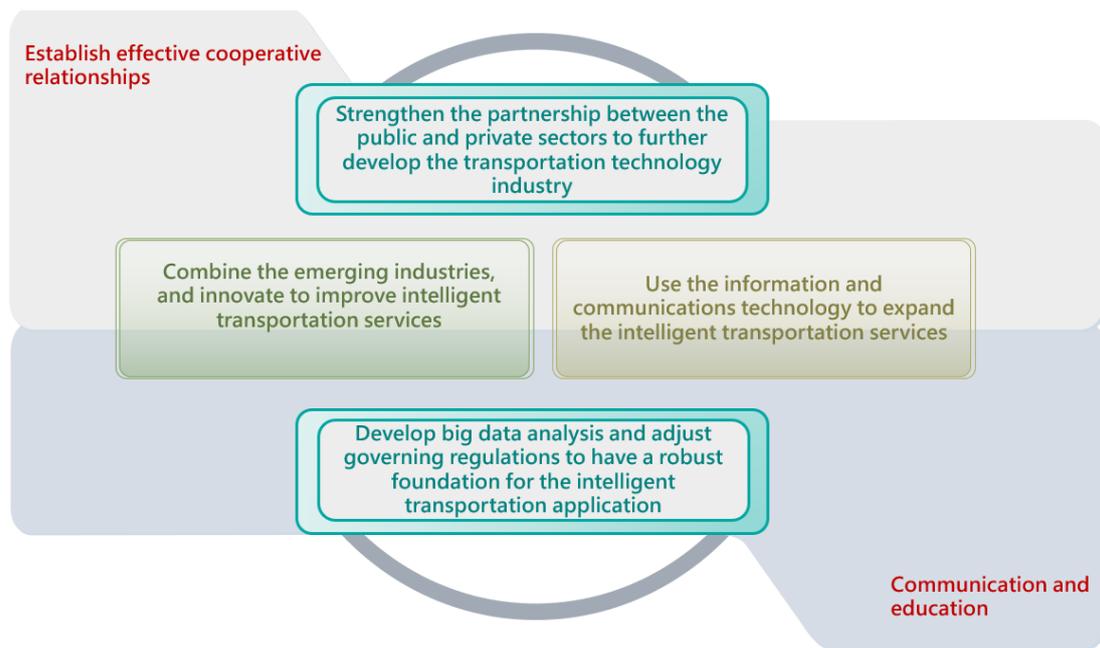


Figure 3. The framework of promoting ITS in Chinese Taipei

Source: The 2020 Transportation Policy White Paper (Set) -Vol.6 Intelligent Transportation

2. Chinese Taipei 's Development and Deployment Plan of Intelligent

Transportation Systems (2017-2020)

The MOTC has promoted the Development and Deployment Plan of Intelligent Transportation Systems (2017-2020)^[6] since 2017. It focuses on solving problems such as traffic congestions, inconvenient transportation in remote areas and road safety through systematic methods and integrated intelligent transportation strategies, incorporating emerging technologies and environment forecast. Through the Board of the Transportation Technology and Industry, the MOTC has had abundant communication with related industries and is focused on the expansion and implementation of high-value application opportunities to develop cross-sector technological integration and application. The important results are explained below:

(1) The Research of Internet of Vehicle on Shared Scooter Safety Field Trial

The MOTC conducted the Research of Internet of Vehicle on Shared Scooter Safety Field Trial Project^[7]. In the implementation field, with the introduction of the new intelligent shared scooters and vehicle-to-infrastructure (V2I) interactions, the interactive-sensing roadside devices installed at some more dangerous intersections can detect the vehicle risks and provide warnings through the roadside Changeable Message Sign (CMS). The warning messages are also simultaneously sent to the intelligent scooter for the rider to pay additional attention to the road, which can lower the chance of having accidents and further increase road safety.

This project identified the accident-prone road sections at National Sun Yat-sen University and National Kaohsiung University of Science and Technology based on the records of accidents. The project then analyzed the accidents, and put forward suggestions on how to reduce the number of accidents by improving the traffic infrastructure. Smart pillars were then installed to solve traffic problems, such as speeding and poor visibility.

The sharing system of smart scooters was also introduced to Sun Yat-sen University, National Kaohsiung University of Science and Technology and Fo Guang University, and the data of 190,000 trips from 700 smart scooters was collected for analysis on scooter-riding behaviors.

Furthermore, 10 smart pillars were each installed at National Sun Yat-sen University and National Kaohsiung University of Science and Technology. With smart pillars, traffic at those 20 intersections was tracked, and the effectiveness of the roadside Changeable Message Sign (CMS), which had been installed in the previous project, was analyzed. Through the analysis, it is proven that such a system can effectively reduce the number of accidents. Meanwhile, a vehicle-to-infrastructure (V2I) interaction cloud system standard was proposed for the shared smart scooters to ensure safety.

(2) Project on Integrating the Traffic Corridor Information and Improving Congestion in the Greater Hsinchu area

The MOTC has been subsidizing the “Project on Integrating the Traffic Corridor Information and Improving Congestion in the Greater Hsinchu area”^[8] since 2017. Under the project, the traffic signals at the Jingguo Bridge Corridor were re-timed, and the traffic at both peak and off-peak hours was reviewed for improvement. With the help of AI, image detectors were used to capture the parameter for the traffic flow. Also, the Path-Based Signal Optimization, a software developed by the MOTC, was incorporated for the analysis on long-term data and traffic signal timing. By adjusting the signal timing at the corridor based on both the traffic flow and the time of the year, the software has helped make more consecutive green lights for drivers and thus reduce travel time. Through traffic signal re-timing, the overall travel time at the Jingguo Bridge corridor has been greatly reduced by up to 30%.

(3) Project on the System Integration and Expansion of the Intelligent Transportation Center in the Greater Tainan Area

The Tainan City Government has promoted the “Project on the System Integration and Expansion of the Intelligent Transportation Center in the Greater Tainan Area”, which was given the Merit Award by the MOTC for the “Evaluation on the Development and Deployment Plan of Intelligent Transportation Systems”.

The Greater Tainan Intelligent Transportation Center adopts intelligent technologies on traffic control in order solve traffic congestion in a timely manner. It is Chinese Taipei ’s first intelligent transportation center that covers all aspects of traffic. Its five core systems – “intelligent transportation control”, “intelligent public transportation”,

“intelligent parking management”, “intelligent vehicle sharing”, and “intelligent cloud platform” – include traffic control, real-time bus information, dial-a-ride bus services, taxi sharing and dial-a-ride stands, parking space information, Tainan City T-Bike, etc. Additionally, through the intelligent cloud platform, the general public can enjoy the convenience of having more access to the real-time transportation information, which provides the city residents with a safe and smooth traffic environment.

In addition, Tainan City has also promoted the “Tainan City Traffic Corridor Congestion Improvement Project”. The scope of the project covers the Xinshi Interchange on National Highway No. 8 and its adjacent area. Through newly setup equipment and the use of cross-unit software and hardware, the regional traffic control system has been established to improve the traffic bottlenecks at the entrance of the National Highway. Solutions with the help of either hardware and software have been proposed based on the actual need and traffic control strategies.

In terms of the regional traffic control strategies for Tainan City, solutions were proposed to respond to the traffic circumstances and to solve the bottleneck problems. Meanwhile, the information system on travel time is continuously improved and is applied for popular tourist attractions such as Yuejin Harbor in Yanshui, helping the development of traffic divergence and parking management. Following the project implementation, the traffic of a total of seven road sections around Xinshi Interchange and Anping tourist area have been improved. Travel time is improved by about 6.7% on average (5.52% for Xinshi Interchange and 7.88% for Anping tourist area). The travel time improvement in Yanshui tourist area is by about 3% on weekends, and by up to 68% during Lunar New Year holidays.

(4) Promoting Self-Driving Cars and the Internet of Vehicles in Chinese Taipei

In order to promote the use of self-driving cars and the Internet of Vehicles, the MOTC has been working closely with other government agencies, including National Development Council, the MOEA, the Ministry of Science and Technology, and the Ministry of the Interior on the road tests for self-driving buses. The MOTC also facilitated the legislation of the “Unmanned Vehicles Technology Innovative Experimentation Act” and its related sub-acts.

In addition, the MOTC subsidizes the trial runs of self-driving vehicles in closed fields in Taoyuan City, Taichung City, and Kaohsiung City. For example, a group of unmanned vehicles, either developed domestically and overseas, were introduced and tested in selected fields in Taoyuan City under the “Unmanned Vehicle Test Project”^[9]. The purpose of the project is to ensure if the unmanned vehicles can be used for short-distance travel or can be taken as shuttle buses, with the aim of reducing manpower costs and the number of traffic accidents. A follow-up project, the “Autopilot Bus Applied in Public Transportation Shuttle Trial Run Project” started in 2019. A service model for using the self-driving buses was introduced at the Qingpu Depot of Chinese Taipei Taoyuan International Airport MRT (Airport MRT) to provide pick-up services for the Taoyuan MRT employees. In 2020, the trial area for the project was extended to the adjacent communities of the Airport MRT, such as the shuttle buses running a 1-kilometer-long route between the Airport MRT A17 Station to the Dayuan International Senior High School.



Figure 4. President Tsai Ing-Wen (center of the picture) attends the trial run of the “Unmanned Vehicle Test Project” held in Taoyuan City



Figure 5. MOTC Minister Wang Kuo-Tsai (4th from the left) attends the trial run of the “Unmanned Vehicle Test Project” held in Taoyuan City

3. Chinese Taipei’s Intelligent Transportation System Development and Construction Project (2021-2024)

Following the first period of the Intelligent Transportation Development and Construction Project ^[10] (2017-2020), the MOTC continued the second period of the project (2021-2024), in order to improve the project outcomes as well as to inspire innovations in the transportation industry. The aim of the second period of the project is to develop effective products and services of ITS by means of conducting local trials, fulfilling local needs and expanding the scales of site tests and verifications. With the experience accumulated in deploying and operating various intelligent applications, it is aimed to improve energy efficiency for transportation and to create a more sustainable transportation environment.

During the second period, the project subsidizes local governments to improve the traffic congestions. Solutions include conducting the cross-region traffic control project and alleviating congestions at the intersections between freeway/expressway and local roads as well as in the congestion-prone road sections. From a long-term observation on travel time and traffic flow, the peak hours for the bottleneck roads last longer by coming earlier or ending later than other road sections. The traditional fixed timing

signals are not able to cope with the traffic during peak hours and therefore can result in traffic congestions. However, through AI calculation and also considering factors such as the history traffic flow, seasonal weather, days of the week, a dynamic signal control system has been established to smartly “start signals earlier” or “end signals later”. For instance, the commute time for the commuters in the Hsinchu Science Park has been reduced by 20~30 minutes through the implementation of the “Hsinchu Traffic Control Corridor Improvement Project”, solving the traffic congestion problems that existed for decades. This approach not only brings tremendous economic benefits to the commuters but also indirectly benefits the Hsinchu Science Park.

In short, the development of the ICT industry in Chinese Taipei can be driven by systematic and integrated strategies on intelligent transportation, combining emerging technologies environmental forecasts. The strategies should focus on solving traffic congestions, the inconvenient transportation in rural areas and safety issues. Furthermore, the strategies should also put emphasis on the expansion, promotion, and implementation of the high-value applications. This project expects to reduce the emissions of CO₂e by a number between 100,000 and 250,000 metric tons every year. It is also estimated that after 2024, the CO₂e emissions would be at least 250,000 metric tons less compared to the emissions in the base year.

IV. Mobility as a Service (MaaS)

In recent years, promoting MaaS in city areas has clearly been important around the world. MaaS combines information and communication technologies, ITS services and personalized mobile apps, to integrate various public transportation and vehicle sharing services. Following are some examples of the implementation of MaaS in Chinese Taipei.

1. Demonstration Plan of Mobility as a Service (MaaS) in Kaohsiung Metropolitan

The MOTC initiated the “The future of Mobility as a Service developed and applied as a strategy plan in Chinese Taipei”^[11] in 2016 to analyze the feasibility of introducing MaaS services in Chinese Taipei. Through collecting and analyzing the international strategies on developing MaaS and through identifying the need for domestic users, the

plan put forward applicable service models, fields of application and service contents of MaaS for future development. In particular, the MaaS “MeN▶Go” app, developed under the “Demonstration plan of Mobility as a Service (MaaS)”, has been launched for operation.

Later in 2017, the “Demonstration Plan of Mobility as a Service (MaaS)” was introduced to Kaohsiung Metropolitan and was implemented from November 2017 to December 2020, while the MeN▶Go app service was officially launched in September 2018. This plan involved various stakeholders including the competent authority, information and communications service operators, ticket-booking system operators as well as transportation service operators (such as the MRT, Light Rail Transit, city and highway buses, ferries, taxis, bike sharing, e-scooter sharing, Park & Ride parking lots, etc.) This plan made Kaohsiung the first city in Asia that launched MaaS and has provided commuters and students with discounted transportation fares and convenient travel services. The next step is to continuously expand the service both horizontally and vertically, such as promoting the MaaS passes for short-term travels. The MeN▶Go service features the following:

(1) Identifies target groups and finds pain points and needs

During the early period after MeN▶Go was launched, the e-tickets data and mobile phone signal data collected from Kaohsiung were used for big data analysis to understand the spatial and time backgrounds as well as the patterns of the passengers using the vehicles. The issues found are tackled from a human-oriented perspective based on the concept and practice of thick data. Multiple transportation workshops were also held to gain insights from the target groups on their needs, pain points and expectations of using the vehicles.

(2) Establishes the mobility service ecosystem for public transportation systems and auxiliary transportation systems

The MeN▶Go service has integrated various transportation services under more than 30 transportation operators, including MRT, buses, Light Speed Rail (LSR), ferries, taxis, bike sharing, e-scooter sharing, and Park & Ride (P&R) parking lots. High-quality and seamless transportation service is provided to the general public, thereby creating a robust business environment for the transportation operators.

(3) One-stop transportation services

Since the MeN▶Go service integrates multiple types of transportation, the users can purchase various passes and package tickets with discounted prices via their mobile phone app (or via physical counters). With the electronic ticket, the users can conveniently travel across different transportation.

(4) Provides a variety of transportation passes

MeN▶Go gives users access to purchase different types of passes, including All Unlimited pass, City Bus Unlimited pass, Ferry Unlimited pass, All Bus Unlimited pass, 7-day All Unlimited Student pass and hour passes, to satisfy different needs.

(5) Provides MeN▶Go bonus point redemption for auxiliary access service

With the resources and support from MOTC's Directorate General of Highways and Kaohsiung City's Bureau of Transportation, MeN▶Go provides bonus points for purchasing the passes on the app, which can be redeemed for the use of the auxiliary access services and P&R parking lot. The redemption program can not only encourage more people to purchase passes via the MeN▶Go app, but also smoothen the whole travel for the users.

(6) Creates a 3-win situation for the general public, transportation operators and the government

By increasing the use of public transportation, the MeN▶Go app generates more income for the operators, reduces transportation costs for the general public, lowers the amount of energy consumption and air pollution, as well as the number of traffic accidents.

(7) Attracts more private vehicle users to use the public transportation

According to a survey conducted in February 2020, it shows that 31.84% of MeN▶Go users adopted the public transportation instead of continuously using their own private vehicles. In addition, the monthly pass sales continued to grow during the COVID-19 pandemic period. ^[12].



Figure 6 MeN-Go tickets and integrated transportation services

To attract more users for the MeN-Go service and to expand the service scope, it is planned to not only continue to integrate the transportation services but also cooperate with more businesses to better cater the general public's needs.

2. UMAJI

“UMAJI” is an app developed to integrate public transportation services for the general public. Starting from 2017, the MOTC has conducted the “Taipei Metropolitan and Yilan County MaaS Setup and Operation Project”. The first-generation “UMAJI” APP included real-time information on road conditions, travel planning, estimated travel time, best travel routes, bus ride purchase, dynamic information of buses in Yilan area, etc., providing the users with a one-stop transportation service for cross-website and cross-platform operations. With the help of the app, both Proof of Concept (POC) and Proof of Service (POS) for the Taipei-Yilan corridor have been completed, and the QR code standards have also been proposed.

The second-generation of the UMAJI app, UMAJI+, was developed under the “UMAJI-MaaS Operation Project” by the MOTC in 2019, with the expectation of expanding the services to a nationwide scope. By integrating public transportation, taxis, car and motorbike rentals, and other transportation services, UMAJI+ was aimed at building up four main features for its users: 1) multiple travel mode planning, 2) MRT last-mile shuttle and ride-sharing services, 3) ticket booking redirection across multiple transportation platforms, and 4) enterprise ride-sharing services. However, due to the booming development of domestic e-scooters sharing services and the digitalization of transportation services, the MOTC had to adjust its MaaS strategies and put forward the Government to Business (G2B) services, targeting at the creation of an ecosystem for the MaaS industry by incorporating resources from the private sectors.

In the future, UMAJI will construct an application programming interface (API) for MaaS that integrates travel planning engines, digitalized public transportation services and ticket-booking platforms, to involve services from the private sectors. UMAJI will also serve as a promoter for the integrated MaaS services with the aims to improve the MaaS service ecosystem, promote the MaaS business alliances and put forward effective strategies for future development. In accordance with MOTC’s policies, many companies have started to develop the API of public core engine for MaaS services and have invited other MaaS related businesses to cooperate. Currently, some corporations and organizations from the private sector (such as Hotai Motor, Lion Travel Service Co., Ltd. and Cingjing Sustainable Development Association) and some of the local governments (such as Taichung City, Kaohsiung City, Hualien County, Taitung County and Penghu County) have shown their willingness to take part as demonstrators in such plan. With the public and private sectors working together, examples will be set, and for the following development, it is hoped to involve more private companies to expand the MaaS applications through the MaaS business alliances.

V. Green Airports

Chinese Taipei has four international airports, Taoyuan International Airport, Taipei Songshan International Airport, Kaohsiung International Airport, and Taichung international Airport, and there are also domestic airports located in Tainan, Hualien, and Magong. In continuous compliance with the green policies, in recent years, airports

in Chinese Taipei have not only been greatly promoting the use of clean and renewable energy, but also been certified with the airport carbon accreditation (ACA) and the green airport accreditation by the Airports Council International (ACI). Furthermore, electrification of the vehicle for ground handling facilities has also been promoted.

1. Promoting Clean and Renewable Energy (Installing solar photovoltaic energy equipment on the rooftop of terminal buildings) Complying with the green energy policies, Kaohsiung International Airport, Taichung International Airport, Tainan Airport, Hualien Airport, Penghu Airport, and ANWS (Miaoli VOR) have set up photovoltaic facilities to produce clean and renewable energy. These airports can produce 4,372,000 kilowatts of electricity every year from the solar energy generated and can reduce carbon dioxide emissions by 2,331 metric tons, which is equivalent to the carbon dioxide absorption volume of six Taipei's Daan Park (26 hectares, which is capable of absorbing 389 metric tons per year). Taoyuan International Airport has set up facilities with a capacity of 90kW at the rooftop of the expansion area in Terminal 2, and other airports and land owners have also been encouraged to set up the photovoltaic system. The current installation capacity is 360kW (as shown in Figure 7 and Figure 8).



Figure 7. Photo of the photovoltaic power generation system setup at Kaohsiung International Airport



Figure 8 Photo of the photovoltaic power generation system setup at Taoyuan International Airport

2. Earning the Certificate of Airport Carbon Accreditation under the Airport Council International (ACI)

Being ACI members, Taoyuan International Airport was certified with ACI's Level 2 ACA (Airport Carbon Accreditation) in 2015 and Level 3 ACA in 2018, and Kaohsiung International Airport was certified with ACI's Level 2 ACA in 2014 and earned a Level 3 Certificate in both 2016 and 2020 (As shown in Figure 9). These two airports are among the few airports in the Asia-Pacific region that have received the honor. This indicates that the measures taken in recent years on energy conservation and emission reduction are effective and are widely recognized.



Figure 9. Taoyuan International Airport and Kaohsiung International Airport earn the Level 3 ACA Certificate

3. Joining the ACI Green Airports Recognition Contest

- (1) In 2018, Taoyuan International Airport proposed the “Replacement project of electricity and air conditioning for boarding bridges at Terminal 1 and Terminal 2”. This project won the Platinum Award – the first place (shown in Figure 10) – in ACI’s Green Airports Recognition 2019 in the 10-million to 45-million-passenger traffic category.



Figure 10. Taoyuan international Airport receives the Platinum Award in Green Airports Recognition 2019

- (2) In 2019, Taoyuan International Airport proposed the “Water Resource Management Project”, and Kaohsiung International Airport proposed the “Water Management”. These two projects contested in the ACI Green Airports Recognition 2020 and both won a Platinum Award (shown in Figure 11) in the over-35-million-passenger traffic category and 15-million-passenger traffic category respectively.



Figure 11. Taoyuan International Airport and Kaohsiung International Airport receive the Platinum Awards in the ACI Green Airports Recognition 2020

- (3) The “Taoyuan international Airport Pollutant Reduction Project” proposed by Taoyuan International Airport in 2020 and the “Air Quality Management Program” proposed by Kaohsiung International Airport both won a Silver Award (shown in Figure 12), which is the third place, in ACI’s Green Airports Recognition 2021 in the 25-million-passenger traffic category. Both of the airports will continue their endeavors in becoming green airports.



Figure 12. Taoyuan International Airport and Kaohsiung International Airport received the Silver Award of the Green Airports Recognition 2021

4. Airside Vehicle Electrification In order to reduce greenhouse gas emissions and in response to the government’s electric vehicle policy, Taoyuan International Airport has promoted airside vehicle electrification project since 2018, and completed the

installation of 43 charging points in 2019 (shown in Figure 13). In addition, the areas for fuel vehicles have been regulated by not allowing fuel baggage trailers to enter designated areas. So far, there are about 500 airside baggage trailers, 148 of which have been replaced with electric vehicles. The measure will extend to ground vehicles in the future to accelerate the overall airside vehicle electrification progress.



Figure 13. Airside baggage trailers and charging facilities at Taoyuan International Airport

VI. Green Ports

As global warming becomes more and more serious and the scale of climate change continues to expand, countries around the world are even more concerned about issues regarding greenhouse emissions. Through decelerating the vessels, expanding the use of shore power and reducing the pollution caused by port machines and machinery, the goal of becoming a green port can be achieved.

1. Vessel Deceleration

To promote vessel deceleration, Chinese Taipei International Ports Corporation Ltd. has set up the “Vessel Deceleration Checking System” to check relevant data (as shown in Figure 14). Additionally, through campaigns held by the Vessel Traffic Service (VTS) and other authorities, it is disseminated that vessels within 20 nautical miles should be decelerated to under 12 knots. In 2020, 100% of the vessels within the international commercial port range (3 or 5 nautical miles) were decelerated to under 12 knots, while 49% of the vessels outside the international commercial port range to 20 nautical miles hit the goal.

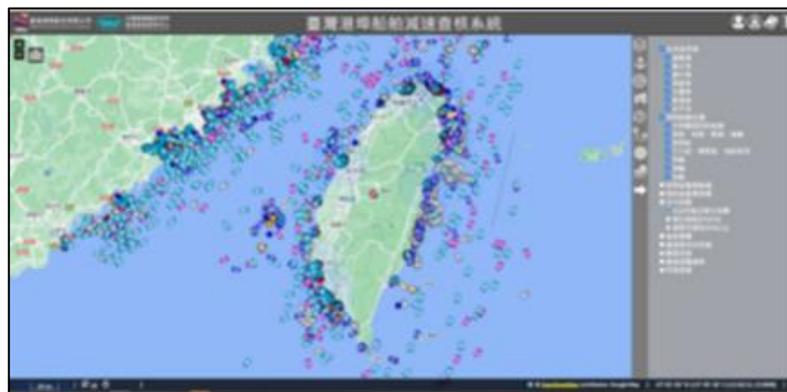


Figure 14 Data on the Vessel Deceleration Checking System

2. Expansion of Using Shore Power

In order to promote the use of shore power, in 2020 low-voltage shore power was used for all harbor boats at international commercial ports in Chinese Taipei, and 31 voyages used high-voltage shore power. To encourage international commercial ships to use shore power, Chinese Taipei International Ports Corporation Ltd. and the Environmental Protection Administration put forward the subsidy project for using

high-voltage shore power, providing incentives and rewards to increase the willingness of shipping companies to use shore power.

3. Port Machine and Machinery () Pollution Reduction

In order to better manage fugitive pollution sources, at all international ports under its jurisdiction, Chinese Taipei International Ports Corporation Ltd. has switched the port machinery to electric or hybrid for the major container areas and the break-bulk cargo yards. The rest of the port machinery in the break-bulk cargo yards uses diesel power that contains less than 10ppm of sulfur to reduce fugitive pollution.



Figure 15. High-voltage shore power connection and electric bridge cranes

As one of the members in the global community, Chinese Taipei has adopted various measures to reduce greenhouse gas emissions in the Transportation sector. The measures include city bus electrification, railway electrification, ITS, MaaS, green airports and green ports. Chinese Taipei is dedicated to facilitating low-carbon public transportation and reducing energy use in the Transportation Sector. In addition, innovative technologies and business models have also been integrated to improve transportation system services. The aforementioned measures and approaches have helped Chinese Taipei to develop a green and low-carbon transportation environment.

References

1. Greenhouse Gas Emission Control Action Project (The Transport Sector), National Greenhouse Gas Emission Reduction Regulations Website, Environmental Protection Administration, Executive Yuan, R.O.C. (Chinese Taipei) (October 19, 2018) Website: https://ghgrule.epa.gov.tw/action/action_doc_page/58.
2. The MOTC Guidelines for Highway Public Transportation Electric Bus Subsidization (July 29, 2020), Website: https://motclaw.motc.gov.tw/webMotcLaw2018/Law/Info?LawID=E0344005&st_op=0.
3. The MOTC Guidelines for Demonstration Project of Electric Bus Subsidization (November 16, 2020), Website: https://motclaw.motc.gov.tw/Law_ShowAll.aspx?LawID=E0400001.
4. Chinese Taipei Railway, *TR News* Vol. 9, Summer June 2016, Website: <https://tip-tr4cdn.cdn.hinet.net/tra-tip-web/tip/file/23f7c7bd-bffb-4aa0-a8c7-3dd2895b0bff>
5. The 2020 Transportation Policy White Paper (Set) -Vol.6 Intelligent Transportation, MOTC, December 2019, Website: <https://www.iot.gov.tw/dl-14688-4afab97951c147a785706f8d6b482295.html>.
6. Intelligent Transportation System Development and Construction Project (2017-2020), MOTC, June 2017.
7. Networked Smart Electric Scooter Safety and Shared Field Test Project: MOTC, August 30, 2021, Website: https://www.motc.gov.tw/ch/home.jsp?id=714&parentpath=0%2C2%2C711&mc_customize=multimessages_view.jsp&dataserno=202108300002&aplistdn=ou=dat a,ou=technology,ou=chinese,ou=ap_root,o=motc,c=tw&toolsflag=Y&imgfolder=img%2Fstandard.
8. Greater Hsinchu Traffic Corridor Integration Road Transportation Information and Congestion Improvement Service Project, Hsinchu City Government, July 31, 2019, Website: https://icity.hccg.gov.tw/ch/home.jsp?id=10023&parentpath=0,2&mc_customize=onemessages_view.jsp&toolsflag=Y&dataserno=201908190001&t=Cityland&mserno=201605010002.

9. Taoyuan City “Unmanned Vehicle Test Project”, Taoyuan City Government, May 26, 2020, Website:
https://www.tycg.gov.tw/ch/home.jsp?id=10412&parentpath=0,10401&mcustomize=news_view.jsp&dataserno=202005260002&aplistdn=ou=news,ou=chinese,ou=ap_root,o=tycg,c=tw&toolsflag=Y.
10. Intelligent Transportation System Development and Construction Project (2020-2024), MOTC, May 2020.
11. Public Transport Mobility as a Service (MaaS) Development Application Analysis and Strategic Planning, The Institute of Transportation, MOTC, November 2017, Website: <https://www.iot.gov.tw/cp-78-10265-956fd-1.html>.
12. I-Hsuan Chen, “Exploring the relationships between Service Features, Perceived Value, Satisfaction and Behavioral Intentions in the context of Mobility as a Services (MaaS)”, Department of Transportation and Communication Management Science, National Cheng Kung University, 2020.