IET Hong Kong

Land Transportation-Aviation-Maritime Technology Symposium 2021

25 November 2021

Transportation of the Future

Ir Eric PANG JP, Director, EMSD

Good morning, Justina, Perry, distinguished guests, ladies and gentleman, It's my great pleasure to attend the Symposium.

An Overview

Transportation plays a major role in the daily life of human being. According to the International Transport Forum, global demand for transportation will continue to grow dramatically by about 2.8 times from now till 2050, or from 44 trillion to 122 trillion passenger – kilometres. At the same time, there is a pressing need to address climate change concerns. Under this background, we are glad to see some emerging technologies that may help address these challenges. Among these, green energy and digitalisation are two mega-trends of technology that are shaping the development of future transportation. I would like to share with you some thoughts on these to trigger more discussion and sharing of insights from experts and fellow practitioners in the sector.

In the history of transportation, the advent of steamboats and steam-engine trains in the early 1800s has enabled goods to be transported over land or sea, for the first time in history, by something other than the power of man, animal, water or wind. Steam engine, the enabling technology, invented in the era of Industrial Revolution was no doubt a disruptive technology at that time. The advancement of transportation technology has since then induced a huge impact on human being over the past centuries.

Transportation is important as it promotes economic development and globalization. In European Union alone, the transport industry directly employs around 10 million people and accounts for about 5% of gross domestic product. Moreover, transport and urban growth are strongly related. Populations in coastal areas and along major rivers, with improved transportation links, are growing faster than those in land-locked inland areas in many countries. In recent years, the introduction of high-speed rail in Mainland China has promoted the integration of cross-city economy and the growth of second-tier cities. All in all, we have seen a huge positive impact brought about by transportation.

Green Energy

In the Industrial Revolution, energy usage increased massively. At the same time, there was a shift of energy source from wood and other biomass to coal and other fossil fuels due to aggravated deforestation and improved mechanization for coal mining. Nowadays, transportation accounts for around 30% of total energy consumption in the world and the majority of the fuel used are oil and coal products. Transportation currently accounts for 25% energy-related CO_2 emissions and around 75% of transport emissions come from road vehicles. In Hong Kong, the energy consumption and fuel usage for transportation are similar to the worldwide trend.

Mission for Carbon Neutrality

The Mainland China, European Unions, United States, United Kingdom, and more than 110 countries have committed to achieve net zero emissions mostly by middle of the century. Hong Kong has pledged to do the same. Reaching carbon neutrality by 2050 requires further rapid deployment of available technologies as well as widespread use of technologies that are not yet available in the market. Major innovation efforts must occur over this decade in order to bring these new technologies to market in time.

Transportation has traditionally been heavily reliant on oil products, which accounted for more than 90% of transport sector energy needs in 2020 despite inroads from biofuels and electricity. To achieve carbon neutrality, transportation has a major role to play. What would happen by 2050? According to a report by International Energy Agency (IEA), electricity will account for nearly 45% of total final consumption in transportation sector by then, followed by 28% for hydrogen-based fuels and 16% for bioenergy.

Adopting Green Energy in Transportation

Electric vehicles (EVs) which have no tailpipe emissions are considered a preferable choice over conventional petrol and diesel cars. The adoption of electric cars has been gaining momentum. In Hong Kong, the percentage of e-private cars among all new private cars has grown from 5.2% in 2015, 12.4% in 2020 to 20% in the first 6 months of 2021, representing 1 out of every 5 new private cars is electric. According to the IEA's Global Electric Vehicle Outlook 2021, a total of 10 million electric cars were on the world's roads at the end of 2020 and the no. of EVs on the roads could surge to over 800 million by 2050.

Comparing with battery EVs, hydrogen fuel cell vehicles offer an attractive new energy alternative given their long travel range and fast refueling. The world's first hydrogen tramcar was invented in 2015 in Mainland China and the technology has been put into commercial operation in Tangshan since 2017. Germany rolled out the world's first hydrogen-powered train in September 2018.

In aviation, electrification only finds application in small aircraft due to the limited energy capacities of batteries. An alternative is the shift of fuel to sustainable aviation fuels (SAFs). The SAFs can be produced from food biomass and non-food biomass sources such as crops, municipal wastes, used cooking oil, and agricultural residues. According to the trend assessment made by the International Civil Aviation Organization in 2016, a 100% substitution of aviation fuel with SAFs could reduce 63% of the carbon emissions from international flights in 2050. On the use of hydrogen, the introduction of a hydrogen-powered short-range aircraft before 2035 could be an inspiring mid-term target according to a European study report.

Marine sector has been working on different solutions, including electric ships powered by lithium-ion batteries, various renewable energy and hydrogen fuel to find an alternative to fossil fuels. Early this year, the world's largest all-electric ferry has gone into service in Norway. Besides, trial on the world's first hydrogen-powered passenger vessel is being conducted in Belgium.

Initiatives in Hong Kong

In Hong Kong, the Government released the Climate Action Plan 2050 in October 2021, outlining four major decarbonisation strategies and measures, namely net-zero electricity generation, energy saving and green buildings, green transport and waste reduction. On green transport, the Government aims to achieve the long-term target of attaining zero vehicular emissions and zero carbon emissions in the transport sector before 2050, through the electrification of vehicles and ferries, development of new-energy transport and measures to improve traffic management.

The Government set up the New Energy Transport Fund (NET Fund) in March 2011 to subsidise the transport sector, charitable organisations and non-profit making organisations in trying out green innovative transport technologies. As at end 2020, the Fund has approved 196 trial applications amounting to $154 million of subsidy, involving 163 e-commercial vehicles, 103 hybrid commercial vehicles and 9 technologies applicable to conventional buses or ferries.

In March this year, the Government announced the Hong Kong Roadmap on Popularisation of Electric Vehicles, setting out the long-term policy objectives and plans to promote the adoption of EVs and their associated supporting facilities in Hong Kong. Apart from promoting electric buses and commercial vehicles, the Government also plans to collaborate with the franchised bus companies and other stakeholders in the next three years to test out hydrogen fuel cell buses and heavy vehicles. The Government will cease the new registration of fuel-propelled and hybrid private cars in 2035 or earlier.

In aviation, a Hong Kong-based airline has announced their pledge to use SAF for 10% of their total fuel consumption by 2030.

In the marine sector, the consultancy study on green ferry technologies commissioned by the Environmental Protection Department concluded that electric ferries were applicable to in-harbour ferry routes operating at shorter sailing distance and lower speed. The Government is going to launch a pilot scheme for electric ferries in 2023.

Hydrogen as a Fuel

As said, hydrogen-based fuels will account for 28% of total final consumption in transportation sector in 2050, second to electricity (45%). However, high production cost and high energy losses are various barriers hindering the production of hydrogen in a clean manner. Colors are commonly used to describe the technology options for producing hydrogen—black for hydrogen produced with coal as part of the production process, grey for natural gas, blue for natural gas with carbon capture and storage, turquoise for natural gas via less-proven pyrolysis technology and finally green for renewable electricity via electrolysis.

Life-cycle emissions from fuel cell vehicles powered by grey hydrogen are only 26% less than that from new gasoline vehicles, while 80% lower emissions can be achieved if the vehicles are powered by green hydrogen. Although there is a huge difference between grey and green hydrogen on the greenhouse gas emission, less than 0.7% of current hydrogen production is green.

Turquoise / Green hydrogen

It is expected that hydrogen production will be dominated by green hydrogen, and it will become one of the key sources of fuel in 2100. Currently, green hydrogen production mainly relies on the electricity from renewable energies plant to carry out electrolysis.

This could be three times more expensive than that of grey hydrogen. Besides, there is about 30-35% energy loss in the production process.

A novel alternative in between blue and green hydrogen, or turquoise hydrogen, is 'methane pyrolysis' which directly splits methane into hydrogen and solid carbon. Further breakthrough is required to produce green hydrogen in an economical way. Ingenious ideas are being explored by academia for a more readily available and low-cost green hydrogen, including speeding up of the electrolysis process by photocatalysis and using active flow membraneless electrolyzer technology.

Digitalisation

Enabling technologies for Digitalisation

So much on green technology, and let's switch to digitalisation. We are said to have entered the era of Fourth Industrial Revolution (4IR). The previous industrial revolutions were driven by steam, oil and communication and this latest one is very much driven by data. Constellations of smart, connected devices, faster wireless internet, "big data" and artificial intelligence are transforming the global economy right now. On communication, 5G is being rolled out while 6G is proposed to integrate 5G with satellite networks for global coverage. 7G is set to deal with space roaming.

The improved connectivity will be vital for real-time data gathering, and it will enable planning simulations using artificial intelligence and machine learning, leading to more efficient, more reliable, and safer traffic management systems. IoT devices are predicted to reach 25 billion by the year 2025. Even the 5G communication systems cannot support such a high number of IoT devices. It is predicted that the International Telecommunication Union will complete the standardization of 6G by the end of the year 2030. The 6G wireless communication network is expected to integrate the terrestrial, aerial, and maritime communications into a robust network. 6G will bring a new industrial revolution termed as beyond the Industrial 4.0 era, where fully automated vehicles will take part in the real-time diagnostics, operations, monitoring, and maintenance processes in a very efficient and cost-effective manner.

Traffic Management

The Hong Kong Government has been applying digital & AI technology to develop a new Traffic Data Analytics System to analyse various traffic and transport data. By enabling more accurate assessment on traffic conditions and providing real-time advice, the system

will allow Transport Department (TD) to further enhance traffic management through more effective handling of incidents and dissemination of information. The relevant information will also be made open gradually via TD's mobile app "HKeMobility" and in machine-readable format on the Public Sector Information Portal.

Also, as one of the Smart Mobility initiatives, "New Generation of Parking Meters" are developed to replace all the existing meters in 2022. These new parking meters are equipped with sensors to detect the availability of road side parking space and provides real-time parking space information to motorists via the mobile apps "HKeMeter", apart from enhancement to allow more convenient payment methods. On the other hand, the Energizing Kowloon East Office has launched the "Smart Parking Mobile App" scheme to provide real-time parking vacancy data of participating carparks in Kowloon East for access by drivers through the "Easy Parking" function in "My Kowloon East" (MyKE) mobile app.

Smart Operation and Maintenance in Transportation

In addition to traffic and logistics management, digitalisation has also found applications in operator-related aspects and O&M of transportation system and infrastructure.

On O&M aspects, real-time evaluation of the in-flight health and performance of gas turbine engines has been in use in the aviation industry for quite some time. Big data presents a multitude of opportunities for the aviation industry in streamlining maintenance, improving safety, and optimizing fuel efficiency. The same are being applied to other transportation systems especially the asset intensive one such as railway.

On operator-related aspects, in-vehicle monitoring systems have been developed for driving behaviour analysis to improve driving skills. Autonomous transport is perhaps a kind of smart operation in the extreme form.

Autonomous Transport

For our future transportation, it is widely accepted that autonomous transport will play an important role. Autonomy will make road vehicles smarter, create opportunities for new services such as last-mile delivery by drone, and deliver fully autonomous urban transportation mode. The UK's Transport Vision 2050 anticipates that the urban transport system, air transport, rail freight and ferries to and from UK islands will be fully autonomous by 2050. Besides, 90% of motorway heavy goods vehicles will be autonomous by 2050.

In Hong Kong, the Transport Department has been facilitating the trials of Autonomous Vehicles (AVs) by issuing Movement Permits in accordance with the Road Traffic (Registration and Licensing of Vehicles) Regulations since 2017. I understand the Airport Authority Hong Kong has put the Autonomous Electric Tractor into operation since 2019 for better cargo and baggage delivery, and has plans in hand to build a dedicated autonomous transportation system connecting the Hong Kong International Airport, the Hong Kong Port of the Hong Kong-Zhuhai-Macao Bridge, and Tung Chung Town Centre. In parallel, the Government is working on a new regulatory framework to enable the wider trial and use of AVs, with a view to paving the way for the long-term development of AVs in Hong Kong.

Autonomous transport is also expected to have a significant impact on both maritime and aviation. In 2018, Finland launched the world's first autonomous ship, a car ferry which utilised AI to achieve automatic berthing and avoid potential collisions without the need of any human intervention. Later this year, the first crewless, fully electric-powered container ship is set to make its maiden voyage between two Norwegian ports using autonomous technology.

In the airspace, while automation has been in place, to a certain extent, for decades, it's still a far leap from going actually pilot-free, but the direction is to automate as much as possible while keeping a human in the loop, and to have pilots in cockpits eventually replaced by ground-based controllers.

There are also several prototypes of larger Unmanned Autonomous Vehicles being tested with the potential to enter the market as point-to-point air taxis, short-range air shuttles or even intercity fixed flight operations as soon as 2025. Despite the more stringent technical and regulatory requirements, unmanned flights for passengers are clearly on the horizon.

Shared mobility

With the highly–advanced communication technologies nowadays, shared-mobility services have been making increasing impact on urban mobility in many countries around the world. The Baltics and Poland are welcoming markets for shared mobility services. The European Commission published the policy note "Cities towards Mobility 2.0: connect, share and go!" in 2020, which provides cities with a comprehensive overview on shared-mobility concepts and practices. Shared mobility can facilitate a shift away from reliance on personal vehicle.

The concept of “Mobility as a Service” (MaaS) is a typical example where mobility will be considered as a single consistent service rather than as a group of different and independent mobility services. The key point about MaaS is that it envisages users buying transport services as packages based on their needs instead of buying the means of transport. By shifting travel away from personal vehicle use, shared mobility can lead to a reduction in vehicle kilometres and in CO2 emissions. It comes as no surprise that shared mobility crosses with electrified AVs. In fact, driverless robotaxis have been reported to be launched in Beijing and Shenzhen this year.

Concluding Remarks

At the moment, it is not crystal clear how transportation would look like in year 2050 or beyond. With advancement in technology, we may be having much faster means of transportation, closest to an “Anywhere Door” (隨意門) from the Doraemon manga making use of the wormhole for space-time travelling. Yet, green energies and digitalisation should continue to be two main areas for development of sustainable and smarter transportation. Speakers of the Symposium today would certainly shed more lights on these.

This year, the Electrical and Mechanical Services Trading Fund (EMSTF) is celebrating the 25th anniversary with the theme of "Co-innovate and Co-create Our Future", which signifies that the EMSTF will strive ahead together with our clients, members of the trade and other stakeholders, passing on its wisdom and culture while unlocking unlimited possibilities for the future, for the betterment of the public and the community.

In the same spirit, I sincerely appeal for your support in building a smart and green transportation for Hong Kong.

Finally, I wish you a very interesting, fruitful and enjoyable Symposium!

Thank you.