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Uncertainties in the Provision of Electric Vehicle (EV) Charging Facilities in Hong Kong: Implications on Public and Private Realm Assets and Resources

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Abstract

The transition to electric vehicles (EVs) is coming, faster in some places than others, but the change is inevitable. Some governments are starting to embrace the shift and rapidly work to develop new opportunities, whilst others choose to smooth the road with more cautious approaches. The potentials and implications of dealing with the resultant changes remains uncertain and largely unresearched whilst the impacts upon manufacture, supply chains, user behaviour, and the physical environment may be significant. The Hong Kong Government recently announced its own Roadmap of transition to an electrified vehicle future, following a decade of stuttering ambition. What can be expected?



The Road Ahead

The Hong Kong Government announced the 'Hong Kong Roadmap on Popularisation of Electric Vehicles' (The Roadmap) in March 2021, setting out long-term policy objectives and plans to promote the adoption of electric vehicles (EVs) and their associated supporting facilities in Hong Kong. Announcing The Roadmap, Secretary for the Environment, Mr Wong Kam-sing, declared that *"We have formulated our first Hong Kong Roadmap on Popularisation of EVs, which will guide Hong Kong's future direction to attain zero vehicular emissions before 2050.*

This acts in concert with our other target to strive for carbon neutrality in the same time frame, and forges ahead with the vision of 'Zero Carbon Emissions•Clean Air•Smart City'" (HKSAR Information Services, 2021a).

Electrification it seems then, is set to reshape the global automotive market over the current decade, as governments urgently need to address both the carbon goals required to meet international 2030 climate targets, as well as the serious health impacts of urban pollution. Whilst the issues of

the climate emergency are increasingly shaping national policies globally, the longstanding health impacts of air pollution have been continually side-lined. Vehicle exhaust emissions include particulates from diesel engines, nitrogen oxides (NO_x), volatile organic compounds (VOC), carbon monoxide and benzene, whilst metals such as copper, iron, and manganese interact with acidic sulphate-rich particles already in the air, to produce a toxic aerosol (Harrison et al., 2012). A World Health Organization study found that diesel fumes directly cause an increase in lung cancer (IARC, 2012), whilst among children, air pollutants are associated with increased acute respiratory illness, increased incidence of respiratory symptoms and infections, respiratory episodes of longer duration, and lowered lung function. A statistical study in California of children with cancer under 6 years old found that living near smog resulted in a 5% to 11% increase in cancer risk (Heck et al., 2013).

Almost thirty years ago it was known that Asthma, the most common chronic disorder of childhood, was on the rise in the United States and in other industrialised nations, where the prevalence of childhood asthma increased nearly 40% during the 1980s (Weitzman et al., 1992). Many different factors have been associated with asthma, but several studies have linked particulate air pollution with exacerbations of asthma in children afflicted with the disease, with research indicating that infants whose mothers were exposed to higher levels of ultra-fine particles (UFPs) during pregnancy are much more likely to develop asthma (Wright et al., 2021). Young children

generally spend more time low to the ground by virtue of both their shorter stature and the nature of their typical physical activity and therefore experience greater exposure to pollutants emitted close to the ground, such as automobile exhaust and high-density pollutants brought downward by gravity. In addition, when the sources of air pollutants such as automobiles are close to playgrounds and other areas where children play, children and infants in strollers may be heavily exposed (International Programme on Chemical Safety et al., 1986). Notably, brake dust, tire fragments and even tiny bits of road also get into the air and these make up a similar proportion of the airborne particulate matter resulting from vehicle use as do exhaust emissions (Harrison et al., 2012). Whilst brake pad dust may come to be reduced through the regenerative braking systems of EVs, which don't use brake pads most of the time, tyre and road dust will endure, and as a result, so will roadside air pollution.

Hong Kong government has been targeting roadside air quality improvements primarily through regulating the exhaust emissions of commercial vehicles, whereby they consider that 90% of roadside emissions result from this sector (HKSAR LegCo, 2019a). Meanwhile the number of registered vehicles (including commercial vehicles) in Hong Kong has rapidly increased, from just over 690,000 to more than 878,000 in the 8 years from 2011 to 2019 (Statista, 2021); a shocking rise of almost 30% that seems hard to justify or substantiate in terms of meeting declared air quality targets, reducing traffic congestion and promoting public transport as the cornerstone

of transport policy. The Roadmap states that the government now want to stop people buying new cars that run on petrol by 2035, what Wong Kam-sing, called “the most progressive target in Asia” (HKSAR Information Services, 2021b).

By way of comparison, Germany plans to ban all internal combustion engines from the whole country of 82 million people by 2030, and the Netherlands plans to ban all gasoline and diesel car sales by 2025. Norway, a similar sized population to Hong Kong but far less compact, also aims to have 100% of its cars be either an electric or plug-in hybrid unit by 2025 (Nicholas & Lutsey, 2020). The UK, as a means to achieve its stated climate, air quality, and energy security ambitions, brought its previous targets forward by ten years in 2020, in order to phase-out the sale of new petrol and diesel cars and vans by 2030. It has also set a goal of 50% to 70% of the new car market being ultra-low emission by 2030 (UK Government, 2020a). China, which already has almost half the global EV stock, and where 1.1 million EVs were sold in 2018, signalled a shift in policy away from subsidies while implementing quotas. In its 15-year EV draft plan, Beijing set a target for EVs to account for 25% of annual new light-vehicle sales and 20% of new car sales by 2025 (Berman, 2020). The Hong Kong targets may be the most ambitious in Asia but are far from ambitious in a worldwide context.

Former vice chairman and head of product development at General Motors, Bob Lutz, has for some time been predicting huge stranded assets in conventional motor vehicles by 2025, as

manufacturers become rapidly switched towards electric production and municipalities automate public fleet systems (Lutz, 2017). The global EV market demand was estimated at over 2.3 million units in 2019, boosting the existing stock to 7.2 million vehicles, but equal to only about 2.6% of global car sales. It’s currently a tiny part of a huge global vehicle market, but one that is about to explode under a set of new market drivers. As technological progress in the electrification of two and three-wheelers, buses, and trucks advances and as the market for them grows, the range of EVs are expanding significantly (IEA, 2020). The market transition is likely to come much faster than governments are allowing for, with manufacturers already retooling and repositioning to gain market share within the new order, which is certain to hit a rapid tipping point once EVs are close to price parity with conventional vehicles.

Predictions are for average battery pack prices to fall to US\$101/kWh by 2023, it is around this price point that automakers in some markets should be able to produce and sell mass market EVs at the same price and with the same margin as comparable internal combustion vehicles, and they are expected to fall to \$58/kWh by 2030 (Henze, 2020). How many manufactures will continue to be bullish in developing new models of traditional vehicles; at least 10 of the largest automakers are promising to make only electric options, including General Motors, Toyota, and Volvo, with the earliest full transitions slated for as soon as 2025 (McKerracher et al., 2020). Perhaps more tellingly how many potential vehicle purchasers in developed markets would

remain determined to stick to obsolete technology that will rapidly have limited resale value? The purchasing of a conventionally powered vehicle becomes an increasingly risky business month by month as various markets teeter on the brink of a rapid conversion, to one where EVs simply become identified as regular 'vehicles', whilst fossil fuel powered vehicles become adversely branded as 'fuel vehicles' (FVs).

So, the transition to EVs is already starting to snowball in certain markets, yet Hong Kong's "progressive 2035 target" appears to be underwhelming and its watch and wait approach fails to demonstrate the conviction necessary to tackle both the chronic roadside pollution situation and overwhelming burden and cost of urban traffic volumes. Regrettably no intermediate transition targets are provided for 2025 or 2030 to guide the ambition of The Roadmap. Furthermore, the original target of 30% of vehicles to be EVs or hybrid by 2020, which was originally included in the Hong Kong Planning Standards and Guidelines, was diluted in 2011 towards just recommending that 30% of private parking spaces in new buildings to be installed with charging facilities for EVs. This goal has subsequently been rejected by the Secretary for the Environment as "merely representing a vision" (HKSAR LegCo, 2019b).

The writing is on the wall for conventional vehicle models it appears, and the transition may happen far more rapidly than the government anticipates. A perfect opportunity is provided at this moment to be proactive, rather than reactive,

to look holistically at the number of vehicles desirable in the city, to visualise how streets might be transformed to create cleaner and better places for living, to use the limited and costly public space more efficiently, and to improve health and safety outcomes. Cities globally are intensively reviewing the part private vehicles have to play in dense urban areas. Their presence is increasingly contentious and looks particularly threatened in London, Paris, Milan, Madrid, and other leading urban centres. The renaissance of these cities' is being led by Mayoral departments with a strong collective vision for across-the-board environmental progress. How can Hong Kong, run by the siloed departments of civil service, be expected to achieve similar significant vision for widespread change? How can the Environmental Protection Department alone, be expected to form, shape, and champion such planning and transport policy?

The Hong Kong Formula

Hong Kong's slow transition to EVs has indeed mimicked that of other developed Asian economies such as Singapore, Korea, and Japan, however this watch and wait approach could mean that these cities are now all able to move forward more rapidly on the knowledge development coattails of early adopting countries. According to the Environmental Protection Department, there were about 15,200 EVs on the road in Hong Kong at the end of June 2020. However, there were only 3,125 charging stations

available, meaning one charger for almost five EVs in the city. As EVs usually take a few hours to charge, their owners often encounter long queues and sometimes become frustrated by the complexity of the charging stations (Ho, 2020). Lack of charging infrastructure has been well documented as one of the biggest roadblocks to EV expansion, along with variations in charging load and lack of standardisation being further drawbacks. Over half of the drivers in UK surveyed by the Department for Transport, indicated that charging concerns were preventing them from purchasing EVs (UK. Government, 2020b). Different countries have their own standards such as CCS (Europe, the U.S., and Korea), CHAdeMO (Japan), and GB/T (China). Some electric manufacturers such as Tesla, have focused on overcoming this obstacle by having their own charging network. The UK is one of the few governments that actually has a comprehensive strategy for electrification, with both an official Office for Low Emission Vehicles (OLEV) and an electrification strategy called the Road to Zero strategy. This anticipates that the vast majority of drivers will choose to charge at home, however the strategy aims to provide further charging options to the remaining one-third of households that don't have off-street parking available, by adding public, street-charging pillars and integrated lighting poles (UK. Government, 2018). This street deployment will not only have significant implications for the visual quality of the urban fabric and street environment but would also seem to continue to encourage the long-term use of private vehicles in urban locations, as against broader policies encouraging

transitions to more sustainable transport modes including public transport, walking and biking. In so doing, inefficient use of valuable public space is further promoted, whilst the negative impacts of deaths, injuries, stress, air and noise pollution, along with the economic losses of social cohesion are ignored. These generally fall most heavily on the poorest and most vulnerable in society, those that don't own private vehicles (Douglas et al., 2011).

Worryingly, the Hong Kong government is studying approximately ten on-street locations for installing charging facilities (HKSAR Information Services, 2019a). The US is adopting a different approach, putting emphasis on charging opportunities being made available at stations, workplaces and public destinations and letting utility providers and the market provide suitable locations for other service provision. These have developed along interstate highways and public parking lots across the country (US. NREL, 2020), and locations can be pinpointed by using the Alternative Fueling Station Locator app tool from the U.S. Department of Energy's Alternative Fuels Data Center (Alternative Fuels Data Center). With charging availability in mind, the central government of China launched its *Guidelines for Accelerating the Plug-in Electric Vehicle Charging Infrastructure Deployment* back in in 2015, to create an adequate charging infrastructure network to meet the nationwide goal of introducing 5 million EVs by 2020 (Ji & Huang, 2018; Wang & Ke, 2018), as outlined by the State Council in its 2012 Development Plan (CN. State Council, 2012). By the end of 2020, 4.92 million

new energy vehicles (NEVs), including battery electric, plug-in hybrid, and fuel cell vehicles, were operating on China's roads. China's success in developing the EV market has been built on a clearly articulated vision, consistent planning, coordinated action, city-level innovation and leadership, policy implementation, and the continued adaptation of policy tools to meet the changing market (He & Jin, 2021).

The current HKSAR Government EV strategy is enshrined within Chapter 4 of The Roadmap (HKSAR 2021). The policy rationale behind it remains somewhat opaque, yet looks primarily towards overnight home charging in the private sector for both cars and commercial transport, whereas for the public transport sector, provision is intended to be located at depots and transit hubs. The government looks to provide support to transition through financial assistance in developing home based charging infrastructure rather than construction of public facilities. Fees for EV charging at government car parks are intended to be introduced from around 2025 however "to promote marketisation of EV charging services". The key measures relating to charging infrastructure under The Roadmap cover various aspects including notably: -

- expanding the EV charging network **on all fronts** and marketising charging services progressively;
- striving to legislate a producer responsibility scheme for retired EV batteries in the next few years, and promoting green technologies of

second-life applications of EV batteries; and

- adopting a multi-pronged approach in creating a conducive environment for the popularisation of EVs. This includes: -

1. establishing a task force to examine the high-end development of new decarbonisation technology globally,
2. the \$200 million Green Tech Fund to fund the research and development of green technologies,
3. making good use of development in technologies including the Internet of Things, big data and artificial intelligence, and
4. seizing opportunities to be brought about by the EV technological development in the Guangdong-Hong Kong-Macao Greater Bay Area, etc

"As EV technologies are rapidly evolving, we will review the various strategies and targets of The Roadmap around every five years. Taking into account new technological, environmental, social and economic development and situations, we will adjust in time Hong Kong's policies and measures in promoting EVs, ensuring that we keep up with the times" Wong Kam-sing has stated (HKSAR Information Services, 2021b). The Chief Executive meanwhile announced in the 2019 Policy Address the preparation of a \$2 billion pilot subsidy scheme to promote the installation of EV charging-enabling infrastructure

in car parks of existing private residential buildings, enabling EV owners to install chargers at car parks of their residences according to their own needs in the future. The EV-charging at Home Subsidy Scheme (EHSS), which financially assists car parks of private residential buildings to install (EV) charging-enabling infrastructure subsequently opened for application from October 2020. Apart from launching the EHSS, other promotional measures include granting gross floor area (GFA) concessions for the installation of EV charge-enabling infrastructure in car parks of new buildings, as well as intending to install more than 1000 public chargers in government car parks in the three years starting from 2019 (HKSAR Information Services, 2020).

The Method Behind the Strategy

So just how was The Roadmap formulated? Whilst Hong Kong has a strong track record of growth planning through harnessing census information to anticipate future requirements, there has been little or no EV data to work with up to this point, and as with any emerging technology, few studies have been published to date. Whilst a plethora of research can be expected in the next few years, little exists before 2018 and this may lack usefulness due to the pace of global change in the sector. Local research has focused primarily on energy management and software techniques related to grid capacity (Hu et al., 2018; Song et al., 2017), whilst studies analysing the framework conditions for the medium to long-

term demand for charging infrastructure remain rare globally. This means that the question of how much public charging infrastructure is needed cannot be answered equally for all countries (Funke et al., 2019). Meanwhile the speed of battery development and the unique development landscape of individual nation states, has made for hugely differing approaches to EV adoption and rollout of battery charging facilities. There are significant unanswered questions about the deployment of EV charging infrastructure and the associated policies that will need to be addressed to help pave the way for electrification (Hall & Lutsey, 2017), not just in Hong Kong but globally. Moreover, 2-wheel EVs and other electric mobility devices (EMDs) which are increasingly popular globally, whilst already classified as “motor vehicles”, are in fact currently illegal on Hong Kong’s roads and pavements (HKSAR Information Services, 2019b), and are therefore completely overlooked in The Roadmap. For Hong Kong, this dearth of information appears to be particularly significant due to space constraints and high land costs, making decision making critical.

In fact, a Steering Committee for Promotion of Electric Vehicles (SCPEV) had been established in Hong Kong as long back as 2009, chaired by the Financial Secretary, however since then there has been extremely limited progress on adopting EVs, either for the private and commercial sectors, or for public transport use. The Productivity Council launched a two-year, HK\$10.8 million, Plug-in Hybrid Electric Vehicle (PHEV) technology project in 2010 (Guo, 2010) and subsequently developed the first-ever 'Made by Hong Kong' electric bus

in 2015, as being the R&D outcome of a close to \$40 million, government funded project intended to cater to the unique traffic conditions and operation model of local franchised bus companies. The Government fully subsidised the companies to procure thirty-six, single-deck, electric buses for trials to assess their operational efficiency and performance. Undersecretary for the Environment, Tse Chin-wan, told lawmakers in 2019 however, that the high population density and uneven terrain made it difficult to use electric buses on a large scale in Hong Kong. Meanwhile, a two-year trial utilising forty-five, BYD manufactured, 'e6' taxis started in 2013, but was halted by the Government after a lack of support provided both to and from the industry. Shenzhen contrastingly, had already converted its entire fleets to 6,000 Electric Buses and 22,000 Electric Taxis by 2019, whilst at least 95% of newly procured civic fleet vehicles were electric, including goods delivery, buses and coaches, logistics, construction and sanitation vehicles as well as vehicles for warehousing, port, airport and mining operations (HKSAR LegCo, 2020).

So, what happened to the government's initially bold and advanced intentions of steering towards an EV economy? As reported in the 2016 Policy Address, the number of EVs had grown from 96 in 2010 to a paltry 4198 by end 2015, with the government stating that "private EVs should normally be charged at their owners' home or workplace. The public charging network is to provide primarily opportunity charging to extend their travel range when needed" (HKSAR LegCo, 2016a). Members of the Legislative

Council Panel on Environmental Affairs expressed repeated concern that the insufficiency of EV charging facilities, citing that they were critical in promoting a wider adoption of EVs in Hong Kong, and further providing multiple suggestions on how to improve the network, including increasing public EV charging facilities, introducing roadside, multi-purpose, metered parking spaces, development of mobile apps to share real-time availability, and means of restricting non-EV parking in charging spaces (HKSAR LegCo, 2016b). Yet no studies or research data was undertaken or shared to substantiate these "multi-pronged approaches" and no clear vision, targets or framework have been established by the SCPEV.

By the time of the 2017 Policy Address, just 7231 EVs were registered on Hong Kong's roads and no new policies initiated (HKSAR LegCo, 2017a). The key promotion measures remained as: the 'first registration tax' (FRT) waiver which had been in place since 1994 (HKSAR Information Services, 2015); GFA concessions to encourage developers to put in place EV charging infrastructure in the private car parks of new buildings, introduced in 2011; company profits tax deductions, lower annual licence fees and the research initiatives under the Pilot Green Transport Fund (PGTF), also of 2011, along with the subsidy financing of the thirty-six, franchise buses detailed above (HKSAR LegCo, 2017d). One of the major barriers outlined at this time was the difficulty in installing EV chargers in existing private housing estates, requiring permissions from reluctant owners' corporations or property management

companies. The solution applied to address these problems was the establishment of a dedicated team and a hotline provided by Environmental Protection Department (EPD) to share relevant information and give technical support to parties and individuals who were interested in installing EV charging facilities (HKSAR LegCo, 2017b). Then, in a somewhat astonishing and confusing about-turn, the Government abolished the FRT waiver on EVs as of April 2017, replacing it with a cap and rejecting a motion from the Panel on Environmental Affairs for its retention, by suggesting that the waiver was contributing significantly to the huge rise in private vehicle registration and the roadside pollution that went with that (HKSAR LegCo, 2017c). A significant drop in EV registrations immediately followed.

The Ombudsman was subsequently appointed to investigate whether the government's planning for ancillary facilities, to encourage growth of the sector, was in line with policy, and reported in 2019 that inadequacies on the part of EPD and Environment Bureau existed in seven identified areas, noting that the Government had: - changed its policy and measures without clearly explaining to the public the reasons and justifications behind them; made no significant increase in the number of public charging facilities since 2014; seriously underestimated their demand; held inadequate data on the utilisation of public charging facilities at non-government public car parks; managed public charging facilities poorly; and failed to formulate clear, fee-charging policies. Most importantly a lack of long-term support measures was lacking. The Ombudsman

recommended fifteen recommendations for improvement. Subsequently a Legislative Council Subcommittee was established in April 2020 in order to *Study Issues Relating to the Development of Electric Vehicles*, whilst receiving input from various institutions and public interest groups. A review of international case studies, specifically of Seoul, Shenzhen, Singapore and Tokyo, as providing immediate context, along with California and Norway, for reference of early adopters, was undertaken following the production of a factsheet sharing the findings of a very short study undertaken by the Research Office of the Legislative Council Secretariat (HKSAR LegCo, 2020). The Subcommittee, after four meetings, subsequently made five key recommendations: the need for setting targets for promoting the use of EVs; making the incentives of FRT concession more effective; extending the further FRT concessions under the "One-for-One Replacement" Scheme introduced in 2018; reviewing the requirements for granting GFA concessions for charging-enabling infrastructure; and expediting the launch of the pilot scheme to subsidize installation of charging-enabling infrastructure in private residential buildings (EHSS). The Roadmap has essentially been formed out of this subcommittee review process. Having not being able to adopt the usual evidence based planning, and unwilling or unable to formulate a strong visionary policy, Hong Kong has chosen rather more of a business-as-usual approach with slightly tweaked incentives. No sticks are included to assist the new carrots provided.

Potentials of Storage

What is however becoming clear, is that the transformation of the vehicle sector to electrification appears heavily tied to progress in the energy storage and battery sector, and particularly in the immediate term, is reliant upon the capacity for Li-ion batteries to make further progress on cost reduction, energy density, and cycle life. The world's largest maker of rechargeable batteries, Shenzhen based BYD, has developed its 'blade battery', a type of lithium iron phosphate battery (LFP) which is said to be safer and cheaper than many EV batteries as it doesn't include the costly element cobalt. LFP technology is not new but the battery architecture has improved its energy density, which makes it more acceptable for wider use. This battery type is ideal for forklifts, bicycles and cars and is also gaining popularity as a home storage option. Even Tesla is using LFP batteries from Chinese maker Contemporary Amperex Technology (CATL) for its Shanghai-made Model 3. Whilst the industry outside of China has been continually pushing for longer-range performance for EVs and moving to more expensive nickel-rich chemistries in order to achieve that, China has not seen the same imperative and has focused on technologies more suited to urban travel modes with shorter operational distances and repeated performance characteristics, including bus and taxis fleets and municipal service vehicles. These don't require to travel ultra-long distances on one charge but do need low price points to make them accessible to markets and their pack prices at US\$80/kWh

are far more competitive than those technologies using more expensive elements.

Battery storage may also be expected to have profound implications on home charging power utilisation. In-home batteries have in fact become increasingly popular in recent years. The United States Energy Storage Association reported a 10% increase in residential storage deployments from the final quarter of 2019 to the first quarter of 2020. The earliest adopters were largely interested in backup power, but now there's growing interest in the potential of home batteries as a tool to manage solar panels, EV charging and demand response (U.S. Energy Storage Association, 2020). Tesla have brought standardisation to the high-end domestic market with their 'Powerwall', a large scale, heavy duty power bank offering 7kW of power and standing more than 1 metre tall, with similar market products being offered by competitors Sonnen, LG Chem and Enphase; all tapping into the emerging grid services opportunities. Stored electricity can power an EV, run daily power needs such as lights, components and refrigerators and can reduce family energy consumption, but more importantly it can smooth electricity supply loads at peak periods.

The problem with lithium batteries is they only hold enough energy to power an average home for a couple of hours rather than days, so scaling the size to fit exact needs becomes important. Connecting storage directly to a fixed grid means energy can be purchased at low peak tariffs, and then utilised at peak hours, when in fact it

is most needed. That could lower the need for increased sources of peak power demand such as expensive ‘peaker plants’ or a costly upgrade in transmission capacity. Two energy companies in Australia, the government-owned Western Power, along with private supplier Synergy, have utilised Tesla’s bigger solution, the 105kW (420kWh) ‘Powerpack and inverter system’, which is more generally reserved for commercial and utility applications, on a residential scale application. The energy storage capacity has been adopted in order to create a shared community ‘powerbank’ as a alternative to individual Powerwalls, and is available to fifty-two families with solar installations in Meadow Springs in the City of Mandurah. The Energy Minister, Ben Wyatt, commented at the project launch that “At a cost of \$1 per day, each customer participating in the 24-month trial will be able to ‘virtually’ store up to 8 kWh of excess power generated during the day from their solar PV systems in the battery. They will then be able to draw electricity back from the PowerBank during peak time without having to outlay upfront costs for a behind the meter battery storage system” (Lambert, 2018).

In this scenario, every single urban dweller, building, community or institution, even those without access to any energy generating source at all, could be able to part-own, or have access to, a large scale, domestic powerbank; charged from the grid overnight at low peak cost and then used during high demand peaks or resold back to the energy grid as a revenue stream. The product becomes a mass market application and, in this way, the whole population can become peak

demand smoothers’ rather than ‘peak demand users’ and smart applications can allow power utilities to optimise the power supply needs, putting power storage capacity into both the private sector and the ‘commons’ whilst leaving individual citizens as micro-power suppliers; thus, avoiding the need for municipal scale capital investment in battery storage.

The Changing Environment

So, whilst The Roadmap might eventually prove to be the perfect solution for Hong Kong, a current lack of clarity exists in regards to almost all aspects of the provision of charging mechanisms associated with the emerging EV economy. This is true not just for Hong Kong, but globally, and with extremely little empirical data existing in this disrupted and ever-changing sector, there exists huge risk potential for inappropriate or inefficient development in the EV charging environment. The HKSAR Government’s intention to undertake a review of The Roadmap within five years is critical and provides a clear opportunity for the undertaking of concurrent research into the progress of EV charging roll-out, not just with the Special Administrative Region, but globally, and also particularly within the context of Hong Kong’s place within in the Greater Bay Area. This can help frame and guide future government decision making. However, critics suggest the time frames under The Roadmap are too slow and more immediate action is needed to avoid just ‘kicking the can down the road’. Specific areas of further research are urgently needed along with pilot actions to investigate issues including: - the

lack of standardisation in the sector; implications of battery innovation; further sector disruption; who should pay for infrastructure development - a public investment or private initiative; sources of electricity supply; grid burden; scales of provision in quantitative and qualitative terms; provision of 'right charging in the right place'; and implications for space development and the urban realm.

The next five years will be critical in focusing the priorities of investment into charging infrastructure, meanwhile so much of the urban environment is physically and visually shaped by the automotive and energy sectors, with the presence of pylons, petrol filling stations and overhead power cables, and in the future, it may be further augmented by street charging pillars, power banks and supply depots. Decision making needs to take account of the urban design implications and in fact the future character of both urban and rural environments is significantly linked to the progress of battery development and energy dispersal. Power storage is likely to bring somewhat unforeseen changes to the physical environment, which could be significant depending upon how they are integrated and regulated by national governments. Yet the role of energy storage should rapidly touch the lives of all and can further empower urban economies to move away from their fossil fuel sources in the immediate future, whilst generating new revenue streams for the masses by allowing storage and supply to be provided by everyone.

Biography

Barry D Wilson is certified in urban design, landscape architecture and commercial mediation. As founding director of Barry Wilson Project Initiatives he is an award winning practitioner in the field of urban development planning, and acts as advisor to the public and private sectors in sustainable solutions related to urbanisation. Adjunct Assistant Professor at the University of Hong Kong and Vice President of the Hong Kong Institute of Urban Design, he is appointed to the HKSAR Government Common Spatial Data Advisory Committee and was honoured in 2012 by the China International Urbanization Development Strategy Research Committee for outstanding achievements in relation to urbanisation in China. In 2016 he presented the TEDx talk "When Fantasy Becomes Reality" in Guangzhou and received the 2019 Reed & Mallik Medal from the Institution of Civil Engineers for his paper 'An Outline To Futureproofing Cities With Ten Immediate Steps'. His book, "Futureproof City : Ten immediate Paths to Urban Resilience" is to be published by Routledge in September 2021.

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