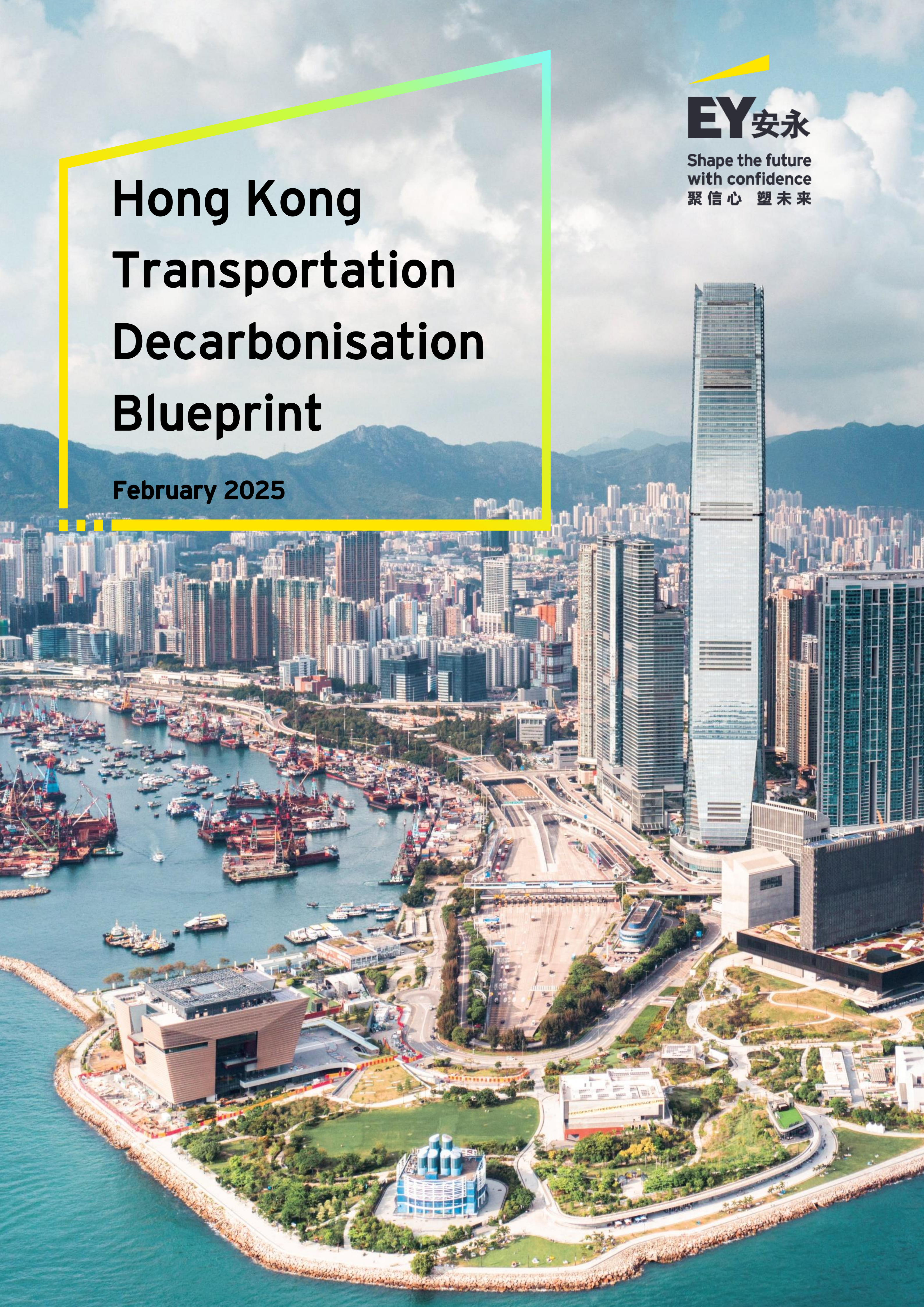
Hong Kong Transportation Decarbonisation Blueprint

February 2025



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Hong Kong Transport Decarbonisation Blueprint

1

The imperative to decarbonise Hong Kong

Global trends and why Hong Kong needs to utilise transport as a central enabler to realise its decarbonisation ambitions

2

Pathways to decarbonisation

What alternative fuel options does Hong Kong have and which segments make most sense for electrification?

3

Challenges and pragmatic recommendations

What challenges do industry stakeholders face today related to transport and what does global experience tell us about how to tackle them?

4

Framework and prioritised actions to accelerate the transition

How should Hong Kong take next steps to deliver on a world class eMobility ecosystem in an efficient and effective manner?

About this report

The global urgency to decarbonise our environment is one of the most important challenges of our generation. The rapid growth in global trade and e-commerce has led to a significant increase in global multi-modal transportation movements of moving essential goods to consumers, posing a significant challenge to the global decarbonisation effort as the global transport sector is responsible for approximately 24% of greenhouse gas emissions.

As the world's 10th largest port, Hong Kong is Asia's premier logistics and maritime hub, serving as a vital gateway for trade between Mainland China and the global market. With its strategic position and ambitious goal of becoming a city of *3 centres 1 hub - finance, shipping and trade and a major talent hub,* Hong Kong is uniquely poised to assume a global leadership role in decarbonising the transport sector.

The rapid development of battery technology and availability of alternative fuels provide an opportunity to decarbonise segments of the transportation sector that were previously hard to abate. Global land and marine transport operations are collectively responsible for substantial greenhouse gas emissions and are progressively transitioning towards low carbon technologies due to mandatory environmental policy and rising strong prevailing sentiment on tackling climate change. Whilst Hong Kong has taken great foundational first steps to decarbonise large parts of the transportation sector, there is still a long journey ahead to transition from early adoption to mainstream acceptance, and to keep pace with other leading port cities around the globe. To make Hong Kong's ambitious 2050 decarbonisation goals a reality, immediate action is required in order for operators to make near-term investment decisions on next generation fuel solutions that are future-proofed for operations through 2050.

In full support of Hong Kong's transport decarbonisation journey, EY undertakes a detailed study of global trends and best practices across both land and maritime transport sectors. Accordingly, EY team's study provides a strategic perspective on (1) The imperative to decarbonise Hong Kong (2) Pathways to decarbonisation (3) Challenges and pragmatic recommendations and (4) Framework for prioritising actions to accelerate the transition.

This report aims to better understand the industry's needs and expectations, explore decarbonisation opportunities, and facilitate future grid planning and optimisation to support the continuous growth and development of eMobility ecosystems. Commercial vehicles in the land transport sector and class I & II vessels as well as shore power in the marine sector collectively represent a significant share of total transport carbon emissions and therefore offer a significant opportunity to progress Hong Kong's decarbonisation agenda.

Throughout the development of this report, EY teams have engaged over 30 industry stakeholder groups across the Hong Kong ecosystem, drawing on their wealth of knowledge, to better understand various perspectives, what is happening on-the-ground, challenges faced and potential pragmatic recommendations to overcome them.

The purpose of this report is to provide policy makers, utilities, industry stakeholders, academia and key eMobility ecosystem players a holistic view of considerations to electrify commercial transport in Hong Kong and to inform strategic planning and investments in abating the barriers to decarbonisation in the city's journey to realising its vision in becoming *"3 centres 1 hub*".

This report draws on EY teams' research and experience across the global eMobility transition and local context, to provide expertise on addressing the specific challenges faced in Hong Kong. The scope of the report is confined to the land and maritime transport sector with a focus on commercial vehicles in land and class I & II vessels in maritime, without inclusion of rail and aviation or other transport sectors.

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- Hongkong International Terminals Limited
- Kerry Logistics Network Limited
- Modern Terminals Limited
- Purus Marine LLC
- Shell Hong Kong Limited
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*Please note that the companies are listed in alphabetical order and do not reflect any ranking or preference. The list presented here is not exhaustive and may not encompass all organisations collaborated in this report.

FOREWORD

As we have reached a critical juncture in the pursuit of carbon neutrality before 2050, it is essential to keep a firm focus on the transport sector, which accounts for approximately 18% of Hong Kong's total carbon emissions, making it the second-largest source of emissions, after electricity generation.

To decarbonise transport, vehicle electrification plays the primary role (especially for road transport), considering its higher energy conversion efficiency over other forms of low carbon alternative fuels, which are more commonly used in hard-to-abate transport sectors such as aviation and international shipping.

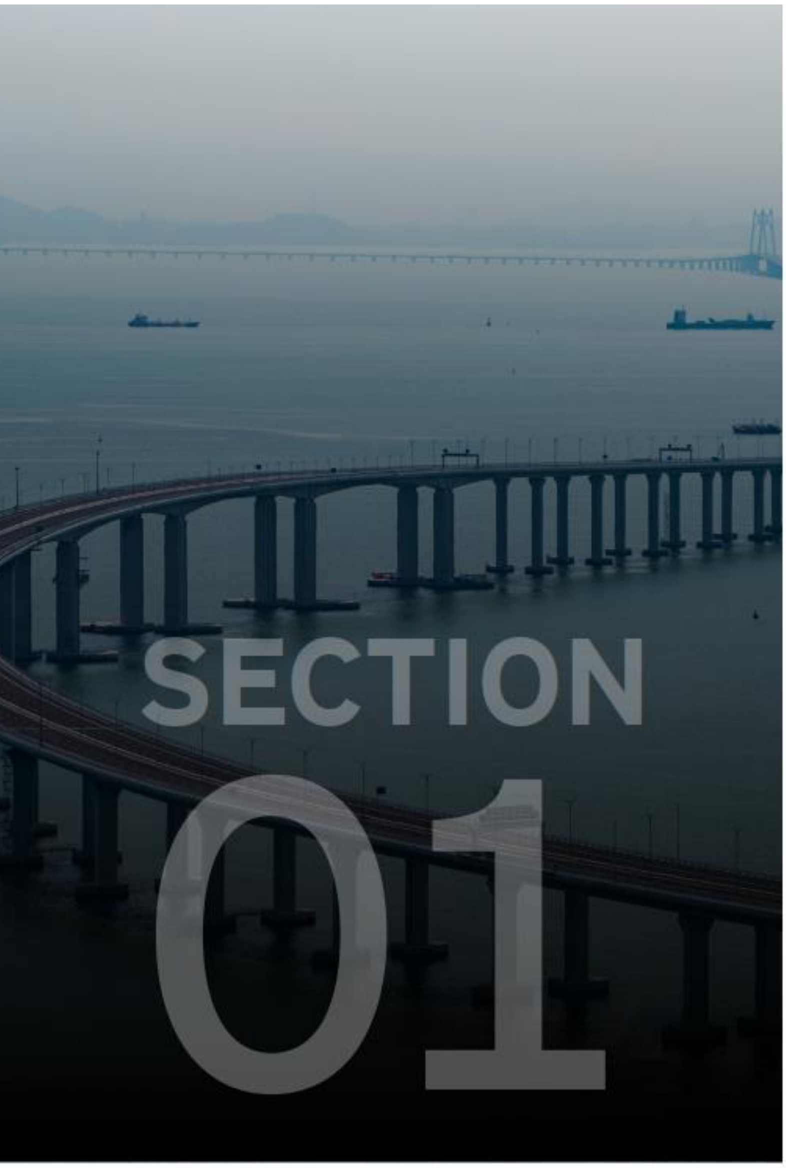
The Hong Kong SAR Government has implemented policies to popularise passenger electric vehicles since 2021. Nonetheless, the energy transition of commercial vehicles, which contribute more significantly to greenhouse gas emissions, is seen to be more complex. Notwithstanding the challenges ahead, the Government promulgated the Green Transformation Roadmap for Public Buses and Taxis in December 2024. Apart from road transport, globally, shore power is being implemented in many major ports and near shore marine vessels are trending towards electrification as a means to decarbonise. In Hong Kong, the Government has initiated several trials among local ferries.

Indeed, the international market is keen on driving electrification developments in both the commercial vehicle and maritime sectors, with significant progress made in recent years. This study is conducted at a good time, as it provides a platform for both the Government and the business sector to understand the barriers and opportunities of transport electrification for the transport sector in the Hong Kong context, and develop suitable strategies to collectively accelerate the transition. The evidence-based findings in this study would provide us with knowledgeable insights on the appropriate policies, technologies and financing to scale up commercial vehicle and maritime electrification. As a membership organisation galvanising business actions towards environmental excellence and net zero in Hong Kong, Business Environment Council is committed to engaging the wider business community to accelerate such a positive move within the transport sector.

Simon Ng

Chief Executive Officer

Business Environment Council



Global trends and why transport as a central enabler to realise Hong Kong's decarbonisation ambitions

The imperative to decarbonise Hong Kong

Key takeaways

- Global scale decarbonisation gaining significant momentum
- Transport sector as central enabler to decarbonisation strategy in HK
- Climate, Social & Health, and Economic Impacts
- Hong Kong Government decarbonisation commitments
- Call for action

Section 1: The imperative to decarbonise Hong Kong – Key Global Takeaways

1 Rising EV uptake:

- Nearly 20% of cars sold globally are now Electric Vehicles (EVs), indicating that the market is moving beyond the early adopters and reaching a broader audience.
- This shift is paving the way for more substantial adoption across various vehicle segments, including commercial and public transport.

2 Focus on commercial vehicles and buses:

- With leading countries setting ambitious targets for 2025-2035, there's a strategic focus on phasing out internal combustion engine (ICE) light goods vehicles (LGVs) and setting partial targets for medium goods vehicles (MGVs) and heavy good vehicles (HGVs).
- This suggests a growing recognition of the need for electrification beyond passenger vehicles, emphasising the environmental benefits and potential long-term cost savings.

3 Benefits for early adopters:

- Early adopters who invest in EV technology now are likely to see quicker return on investment due to financial incentives and lower operational costs and obtaining first mover advantage in locking down operations at strategic locations.
- These companies can also leverage their early experience to scale EV operations more effectively and efficiently.

4 Lessons learnt from markets at the forefront:

- Governments are crucial in providing clarity and direction through well-defined targets and supportive incentives.
- Early adopters and leaders are recognising that there are efficiencies to be gained through first time right policies, reaping early benefits.
- Countries are adopting a mix of levers – In all cases, countries, with Mainland China, Norway and European Union (EU) at the forefront of the transition to zero carbon, are adopting a balanced mix of enablers to support market players, and those that have all these in place are reaping the rewards in early EV uptake.

Section 1: The imperative to decarbonise Hong Kong – Key Global Takeaways

1

The maritime industry is accelerating decarbonisation efforts, this shift is driven by the following factors:

- Recently published International Marine Organisation (IMO) targets are setting the stage for global decarbonisation in shipping.
- The EU is extending its Emissions Trading System (ETS) to cover shipping, with financial penalties for non-compliance starting January 1, 2025.
- The FuelEU Maritime regulation on well-to-wake GHG emission intensity requirements will be implemented from January 1, 2025.
- Industry stakeholders, including charterers, shareholders, lenders, and commodity owners, are increasingly pressuring the sector to reduce supply chain emissions.
- There is a strong international focus on decarbonising shipping, while local and regional initiatives are targeting the decarbonisation of harbour fleets and port operations.

2

Industries are prioritising investment in onshore power supply infrastructure:

- Onshore power supply (OPS) infrastructure investment by global governments has been a focus for emissions-free operation of oceangoing ships while at berth.
- Increasingly, countries in EU and Mainland China are mandating ships to be connected to OPS while berthed (where made available). This includes both cargo and cruise ships, which both produces significant emissions and pollutants from their engines while at berth in close vicinity to high populated urban areas.
- Regionally, Mainland China now offers more than 400 shore power connections across 21 ports. The 14th Five-Year Plan (2021-2025) sets a target of 100% shore power coverage for cruise ship terminals by 2024 and aims to achieve 90% shore power coverage for key container ship terminals by the end of 2025.

3

Opportunities for Hong Kong - electrification of local vessels and river trade:

- For vessels trading domestically, shorter voyage distances are enabling adoption of electric ships up to 700TEU container capacity and 1000+ passengers. In Chinese mainland, provincial governments are pushing ahead to electrify inland cargo vessels in an effort to reduce shipping emissions.
- The majority of vessel emissions in Hong Kong come from ocean-going vessels calling at the port, accounting for 40-90% of total vessels emission. This is followed by local vessels, primarily Class 1 and Class 2 vessels.

4

Electrification of harbour fleets as success stories for decarbonisation breakthrough:

- Ferries and other harbour fleet vessels are increasingly becoming a focus for decarbonisation as technologies improve, with some governments working to develop complete ecosystems to support a growing electric vessel market.
- Globally, e-ferries have proven operationally viable, where Norway is leading the way with more than 80 electric ferries in operation. Elsewhere, New Zealand, Japan, Sweden and Finland have also been implementing e-ferries.

1. The imperative to decarbonise Hong Kong

Global scale decarbonisation gaining significant momentum

The urgency to address climate change on a global scale has gained significant momentum in recent years. The United Nations 2023 Climate Change Conference in Dubai (COP28) called on nations worldwide to review and assess global efforts to combat climate change in accordance with the Paris Agreement. COP28 concluded with a landmark agreement, recognising the need to transition away from fossil fuels in energy systems, including land and marine transportation. With the transport sector currently accounting for around 20% of global greenhouse gas emissions[1], the importance of taking a holistic approach that addresses the transition to zero carbon technologies for both private and commercial owners of vehicles and vessels is paramount.

[1] Transport Overview

Globally, there has been a tremendous response from the public, with consumer demand for electric vehicles showing continued growth over the past five years. While that growth has been admittedly slower than in previous years, due to global geopolitical uncertainty, looming elections[2] and supply shocks due to semiconductor shortages[3] (among other factors), EV adoption remains steady and is expected to continue to grow given robust commitments from policy makers worldwide. According to the International Energy Agency (IEA) Global EV Outlook 2024, electric car market share has reached 18% of total new vehicle sales, with over 14 million units sold[4].

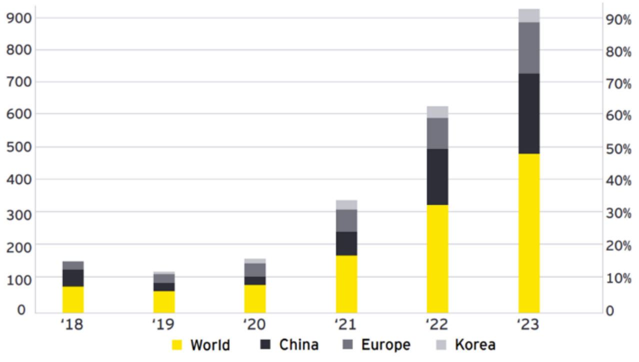
Adoption of EV technology is also advancing across commercial transport owners and operators, though at varying rates for different vehicle categories. The electric LGV segment has shown notable progress, with global sales share approaching 14% in 2023[5], and a significant 50% increase in sales compared to the previous year[6]. In the medium and heavy-goods vehicle segments, the sales are gaining momentum, the global sales of electric truck increased 35% in 2023 compared to 2022[7]. Similarly, e-buses achieved 50,000 sales in 2023, bringing the global stock to approximately 635,000 in total. Below graphs showcase the global sales from 2018 to 2023 on electric LGVs, MGVs & HGVs.

This uptake indicates EV technology is gaining traction in commercial markets across a range of vehicle segments and operational use cases, in large part due to significant investments by governments and industry to achieve ambitious decarbonisation targets. Key provinces such as Guangdong and Chongqing in Mainland China have announced zero-emission truck targets as early as 2025. The European Union most recently (May 2024) adopted new rules requiring 90% emissions reductions from trucks and buses by 2040. Additionally, 26 countries, including large truck markets such as the United States and Canada, aim for 100% zero-emission for new truck and bus sales[8].

Variation in uptake across the different vehicle segments highlights the unique challenges faced by commercial operators. While the widespread availability of suitable vehicle models and related charging infrastructure along transport routes is vital to support transition across all segments, this is especially true for HGVs with higher payload capacity, longer-range requirements and critical fit with business process and duty cycles.

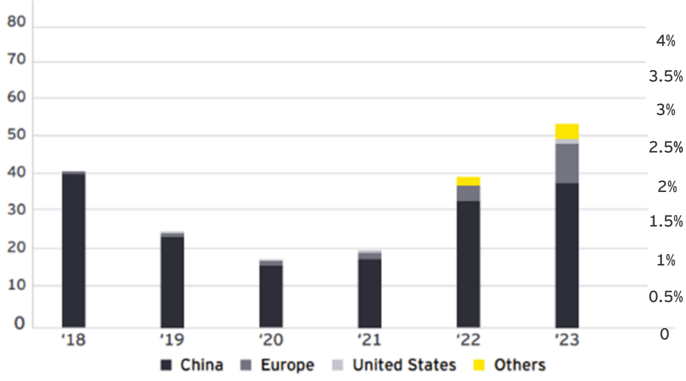
Adoption of EV technology is advancing across commercial transport owners and operators, though at varying rates for different vehicle categories.

Electric LGV global registration (thousands) and sales share, 2018 - 2023



Source: *Trends in heavy electric vehicles – Global EV Outlook 2024 – Analysis - IEA*

Electric MGV & HGV vehicles global registration (thousands) and sales share, 2018 - 2023



[2] Why are EV sales slowing?
[3] How the semiconductor crisis really affects electric cars
[4] Trends in electric cars - Global EV Outlook 2024 - Analysis - IEA
[5] Electric vehicles market monitor for light-duty vehicles: China, Europe, United States, and India, 2023 H1 - International Council on Clean Transportation (theicct.org)
[6] Trends in other light-duty electric vehicles - Global EV Outlook 2024 - Analysis - IEA
[7] Trends in heavy electric vehicles - Global EV Outlook 2024 - Analysis - IEA
[8] In China, a growing body of real-world data on electric trucks - International Council on Clean Transportation (theicct.org)

UN Trade and Development's (UNCTAD's) Review of Maritime Transport 2023 noted that the shipping industry's greenhouse gas emissions have risen by 20% over the last decade and now account for 3% of total global emissions[9]. UNCTAD also called for a "just and equitable" transition to decarbonised shipping, noting that without action, emissions could reach 130% of 2008 levels by 2050.

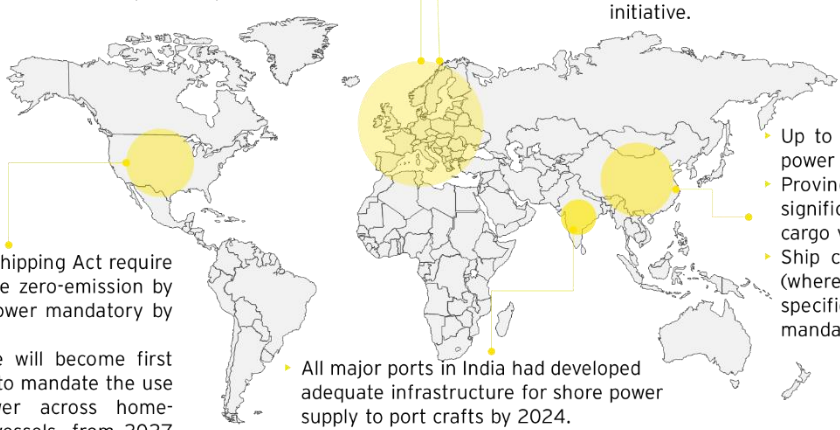
Port and terminal operators are actively responding, with a significant portion of major global ports investing in both shore power infrastructure and electrification of their landside operations. The map on the next page showcases some of the global key developments on onshore power supply. At the same time, shipping companies are starting to investigate new technologies and are building or retrofitting ships to be compatible with onshore power supplies (OPS) and, in a growing number of cases, utilise alternative fuels such as liquefied natural gas (LNG), methanol and ammonia, along with a significant emphasis on electrification of the domestic harbour fleet.

On the supply side, alternative fuel production is growing in response to the International Maritime Organisation's decarbonisation targets. This combined with EU ETS and FuelEU measures further leads to the increasing trend for in service ships to adopt alternative fuel.

The promotion of sustainable cruise destinations has also seen a rise in onshore power developments at ports. The Cruise Lines International Association (CLIA) has announced that all cruise ships will be equipped to use shore power by 2035[10].

More visible examples of decarbonisation efforts can be seen in the commissioning and operation of alternatively powered ferries and harbour fleet vessels. While Norway has around 80 fully electric or hybrid-electric ferries in service[11], the Port of Auckland in New Zealand received a fully electric tug with performance comparable to their highest-powered diesel tug in 2022[12]. Electric tugs are being put into service globally, with cases in Mainland China and more planned. Mainland China aims to increase the proportion of electric ships from 0.55% in 2022 to 18.5% by 2025[13].

Global developments in onshore power supply



Source: EY Research

Note: The above examples are non-exhaustive

[9] Review of Maritime Transport 2023 | UNCTAD
[10] CLIA commits to net-zero by 2050 - SAFETY4SEA
[11] Norway showcases award-winning electric ferry technology
[12] The benefits of electric tug boats
[13] Evaluating China's decade of electrification

Singapore has also launched e-ferries as part of its commitment to decarbonise harbour fleets by 2030[14].

The growing adoption of electric vessels across various segments is boosting market confidence.

However, decarbonising maritime transport in Hong Kong requires extensive coordination among governments, regulators, energy suppliers, operators, and financial institutions, given the scale of the challenge and the complex stakeholder landscape.

[14] Singapore's first electric ferry ready to set sail next month, as maritime sector continues green push - CNA (channelnewsasia.com)

Leading countries in decarbonisation are adopting a mix of levers

In all cases, countries at the forefront of the transition to zero carbon are employing a balanced mix of levers and supports to drive market adoption of zero carbon energy solutions. These can be broadly grouped under three categories, and those countries that have all three in place are reaping the rewards in early and accelerating transport electrification.

- **Policies and incentives** – Do governments have targets and signals to provide clarity and direction to the market, supported by incentives that help alleviate financial challenges?
- **Charging infrastructure** – Have countries developed sufficient charging infrastructure to cater for the varied needs of both public and commercial operators to address operational needs and challenges?
- **Market (and consumer) confidence** – Have market players and governments collaboratively improved electrification's accessibility, appeal, and affordability to boost customer confidence by transitioning their own fleets and providing successful reference cases?

Policies and incentives

Globally, EV uptake is shifting from early adoption to mainstream acceptance - market share of EVs has reached 18% of total new vehicle sales and eMobility markets are now transitioning their focus towards higher opportunity segments such as commercial vehicles & buses. This is being made possible by continued advancements in battery technology and increasing technological readiness of the broader market to tackle the disproportionate share of pollution that commercial transport accounts for. Freight transport, for example, accounting for only 9% of the global vehicles stock and 17% of total vehicle miles drive, is responsible of approximately 39% of life-cycle road vehicle Greenhouse Gas emissions, with even higher shares of air pollutants[15]. Leading countries are setting ambitious targets in 2025-2035 to phase out ICE LGVs with progressive phase out of ICE MGVs & HGVs and are already starting to see results.

In 2023, one in twenty-five LGVs sold globally was electric.

- Sales of electric trucks also increased 35% in 2023 compared to 2022, with total global sales of electric trucks (approximately 54,000) exceeding that of electric buses for the first time.
- Mainland China is currently the leading market for electric medium and heavy trucks, accounting for 85% of global sales in 2022[16].

The "Early Adopters" in the below diagram are a product of the ambitious targets of each country. They also represent those countries best placed to comfortably achieve their 2050 national decarbonisation targets. It's important to note, however, that setting clear and ambitious targets is only one of several actions these countries have taken to drive early and accelerating adoption of zero carbon technologies by commercial vehicle operators.

Countries & cities increasingly set their focus on the commercial vehicle segment with decarbonisation policies and targets

Early adopters: 2025–2035

2025	2030	2035	2040	2045	2050
Norway 100% ZE LGV sales	Norway 100% ZE M/HGV sales	EU Countries 100% ZE LGV sales	California, USA 100% ZE public bus fleet	Chile 100% ZE vehicle sales	China 100% ZE MGV/HGV sales
Denmark 100% ZE public fleet	Netherlands 100% ZE public bus fleet	United Kingdom 100% ZE LGV sales	Mexico 100% ZE LGV sales		Costa Rica 85% ZE public bus fleet
Korea 100% Eco Friendly Gov Fleet	Amsterdam 100% ZE LGVs in the city	New Zealand 30% ZE LGV Fleet	United Kingdom 100% ZE HGV sales		
China 80% NEVs in new buses and municipal LGVs in key regions	Mexico 50% ZE LGV sales 100% ZE public bus fleet	California, USA 100% Drayage Trucks	Singapore 100% electric/hybrid bus fleet		

Light goods vehicle (LGV) · Medium goods vehicle (MGV) · Heavy goods vehicle (HGV) · Buses

Source: EY research

Note: The above examples are non-exhaustive

[15] Decarbonising road freight transport: The role of zero-emission trucks and intangible costs | Scientific Reports (nature.com)

[16] Global EV Outlook 2024

Monetary incentives

As the global focus increasingly shifts to decarbonising commercial fleets, purchase subsidies, tax exemptions & credits, and charging infrastructure incentives are being extended to commercial vehicle operators.

1. *Purchase subsidies and financing programs*

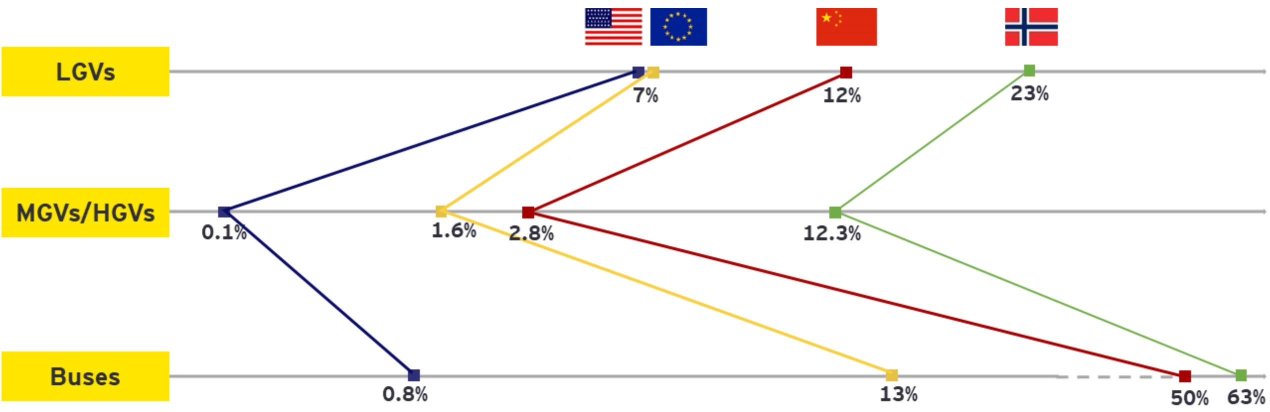
- Some major Chinese Mainland cities such as Nanjing, Chengdu, Guangzhou, and Changsha, provided subsidies to offset upfront and operational costs associated with EV adoption to incentivise the transition of urban logistics and delivery vehicle fleets from 2020-2022, removing subsidies after the development of a self-sustaining market[17]. Other incentives supporting the electric truck adoption included the built-out of public charging facilities, toll-free discounts, already proven useful in Chengdu, and road access privileges and parking discounts[18].
- In India, the government has launched the Automobile and Auto Component Production Linked Incentive scheme to provide monetary incentives for the sale of advanced automotive technology vehicles, including battery electric and hydrogen fuel cell vehicles, across different vehicle segments[19].

Austria offers purchase bonuses ranging from €2,000 to €130,000 for different categories of electric commercial vehicles like buses, vans and trucks until the end of 2023[20].

2. *Tax exemptions and credits*

- In the US, businesses and tax-exempt organisations purchasing qualified commercial clean vehicles could be eligible for a clean vehicle tax credit of up to US$40,000 under Internal Revenue Code (IRC) 45W[21].
- In Mainland China, the policy for the reduction and exemption of vehicle purchase tax on new energy vehicles has been extended until the end of 2027[22].
- Belgium offers a 6% reduced VAT rate on electricity consumption for commercial EVs and allows a 35% deduction on investments in new electric commercial vehicles and related charging infrastructure at the federal level[23].

% new sales share of EVs across commercial segments are driven by policies & incentives, charging infrastructure and customer confidence



Source: EY research

[17] China Continues Support For New-Energy Vehicles Despite Subsidy Phaseout | S&P Global Market Intelligence
[18] Zero-emission_trucks_Sichuan_FINAL.pdf (theicct.org)
[19] Policy developments - Global EV Outlook 2023 - Analysis - IEA
[20] Electric_commercial_vehicles_Tax_benefits-and_purchase_incentives_2023
[21] Commercial Clean Vehicle Credit | Internal Revenue Service
[22] 新能源汽车车辆购置税减免政策延长至2027年年底
[23] Electric_commercial_vehicles_Tax_benefits-and_purchase_incentives_2023

Non-monetary incentives

At the city level, examples of the implementation of low or zero-emission zones for freight are becoming more prevalent. These can be seen in cities such as London, Los Angeles, Madrid, Quito, Shenzhen, Seoul and Taoyuan City, which collectively are home to a total population of more than 52 million people. These zones provide preferential access for electric commercial vehicles, which enhances the business and operational appeal of owning or operating such electric fleets.

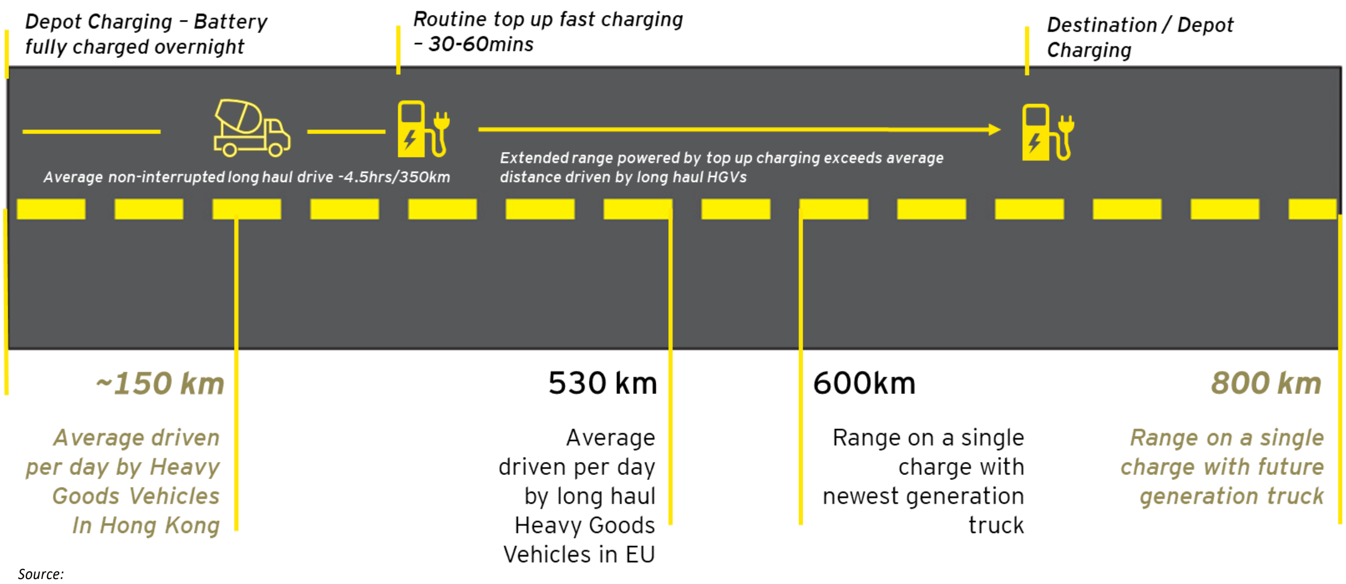
In Mainland China, provincial and local governments are promoting electric vehicles through a range of incentives. According to the Oxford Institute of Energy studies, EV licence plates can be issued quicker, within months in Beijing, compared to years for conventional ICE vehicles. EV owners can also enjoy free or reserved parking spaces in many Chinese cities, including Liuzhou and Shenzhen[24,25].

Charging infrastructure

Reliable and available charging infrastructure has been a pre-requisite to the acceleration of EV uptake globally. In dense urban areas, where access to home charging is more limited, public charging infrastructure is a key enabler for EV adoption. For commercial vehicles, a combination of dedicated charging at point of departure (depot charging), third party charging hubs and public on-the-go charging is typically required to facilitate transition across all commercial vehicle segments, while mitigating operational risks. While depot charging remains the responsibility of the commercial owner/operators, viable on-the-go charging requires government-industry collaboration and partnership in strategically located fast charging infrastructure. At the end of 2022, there were 2.7 million public charging points worldwide, more than 900,000 of which were installed in 2022, about a 55% increase on 2021 stock, and comparable to the pre-pandemic growth rate of 50% between 2015 and 2019[26].

Globally, leading jurisdictions continue to invest in charging infrastructure to serve evolving consumer needs across different vehicle segments, with an emerging focus on improving support for commercial vehicles in many jurisdictions. In the EU, the Alternative Fuel Infrastructure Regulation (AFIR) aims to equip the main road network with charging stations every 60km, enabling electric trucks to operate between Talin and Lisbon[27]. Advancements in technology are also improving the range of electric trucks (see figure below), complementing such initiatives. While it's difficult to agree an ideal charger to EV ratio due to geographic differences between countries and jurisdictions and

New generation of e-trucks are ready for long haul routes



Source:
Enabling conditions | Transport & Environment (transportenvironment.org)
Volvo Announces Electric Truck Range Breakthrough - Fuel Smarts - Trucking Info

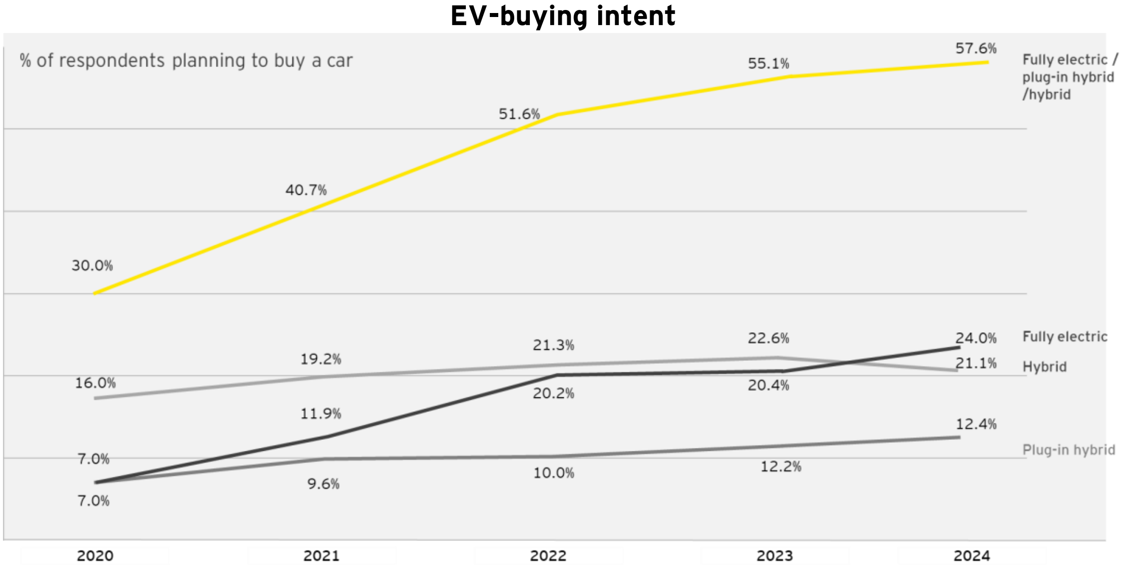
24 Liuzhou: A new model for the transition to electric vehicles?
25 Shenzhen, China: The World Pioneer in Electric Vehicles
26 Trends in charging infrastructure - Global EV Outlook 2023 - Analysis - IEA
27 Enabling conditions | Transport & Environment (transportenvironment.org)

continued improvements in charging speeds and battery densities, it's clear that planning and deployment of charging infrastructure requires collaboration and partnerships between government, utilities and the industry.

In 2022, Mainland China accounted for 90% of new fast chargers deployed globally[28], providing more capacity for rapid charging of privately owned EVs while also enhancing support for on-the-go charging of commercial EVs. In Europe, the European Investment Bank and the European Commission will make over EUR 1.5 billion available by the end of 2023 for alternative fuels infrastructure and electric fast charging[29], which is a new financing mechanism under the EU budget, from institutional investors and private lenders. Similarly, the US has also released its Electric Vehicle Infrastructure Formula program, allocating USD 5 billion from 2022-2024 working with private entities to support the build-out of chargers across 122,000 km of highway, which private and commercial vehicles alike will be able to make use of[30].

Given the significance of charging infrastructure in enabling EV adoption, it's important to highlight the role standardisation and regulation has played in aligning market players and helping to maximise the collective utility from investments made. While standardisation of charging connections between different vehicles and chargers has obvious advantages, less obvious are the benefits that come from data sharing.

EV-buying intent



Source: EY Mobility Consumer Index (MCI) 2024 study

[28] Trends in charging infrastructure – Global EV Outlook 2023 – Analysis - IEA
[29] Europe's alternative fuels infrastructure getting a boost
[30] Bipartisan Infrastructure Law - National Electric Vehicle Infrastructure (NEVI) Formula Program Fact Sheet | Federal Highway Administration (dot.gov)

In the EU, the Renewable Energy Directive (RED)[31], AFIR[32], the Energy Performance of Buildings Directive (EPBD)[33] and the Data Act are all being rolled out. In practice, these arrangements will support the exchange of data and enable services such as optimised bidirectional charging, charge point location for drivers, all while enhancing planning of grid upgrades and future infrastructure developments.

The rate of development of charging infrastructure is directly related to an integrated approach between grid planners, charging infrastructure installers and user groups in identifying optimal locations for charging infrastructure that maximise user convenience and minimise the need for grid reinforcement. Therefore, utilities globally, play a key role in ensuring they are equal to the challenge investing in both enabling smart charging technologies as well as integrated, digitally connected grid infrastructure.

Market (and consumer) confidence

EY Mobility Consumer Index (MCI) 2024 study, which analyses consumer behaviour in relation to emerging trends in the mobility market demonstrates that despite slower pace of global sales, EV buying intent remains strong (see figure below).

As the electric private car segment is starting to transition from early to mass adoption, owing to improved battery technology, availability of charging infrastructure and growing consumer acceptance. These factors, in conjunction with falling battery prices are also likely to boost EV demand moving forward[34], with the commercial vehicle sector set to follow suit behind private cars. Leading global companies, including AstraZeneca, Baidu, BT Group and other fortune 500 companies, have signed up to The Climate Group's EV100 initiative, and are committed to electrifying their vehicle fleets by 2030[35]. In Hong Kong, leading organisations such as CLP and the Airport Authority Hong Kong have also committed to this global initiative.

Notably, many global corporations are moving ahead in the race to Net Zero in prioritising decarbonisation, acknowledging that in doing so they are building more sustainable businesses aligned with environmental, social and governance (ESG) principles. They collaborate with suppliers and customers on emissions measurement and reduction[36]. The diagram below shows some of the targets different global corporations have set for themselves.

Global company / authorities' commitment on EV transition

Logistics	Governments / Authority	Commercial/ Industrial
UPS aims for its entire global fleet to be carbon neutral by 2050, with interim goals that include running on 40% alternative fuels in ground operations by 2025.	The State Council of the People's Republic of China will speed up the full electrification of vehicles used in public transportation between 2023 and 2025, and the building of a charging and swapping infrastructure system that is "moderately advanced, well-balanced, intelligent and efficient".	IKEA plans to use 100% electric vehicles (Eco-friendly vehicle) for nationwide truck delivery by 2025. IKEA joins forces with four global companies by committing to EV 100+ to transition to zero-emission electric trucks by 2040.
DHL Express is committed to electrify 60% of its fleet globally by 2030.	Airport Authority Hong Kong (AAHK) has committed to increase the number of electric powered vehicles over 3,000 by 2030, alongside the expansion of charging infrastructure to over 1,320 charging points.	Gammon has ambition to completely switch the passenger vehicle fleet to electric.
Kerry plans to modernise its fleet by adopting alternative fuel vehicles.	Singapore's Land Transport Authority is committed to achieve a 100% cleaner energy bus fleet by 2040.	PepsiCo will continue to acquire new electric, hybrid and natural gas vehicles to expand our sustainable fleets in the U.S., Latin America and Europe.

Source: EY research

[31] Directive - EU - 2023/2413 - EN - Renewable Energy Directive
[32] EUR-Lex
[33] New rules to boost energy performance of buildings
[34] Lower battery prices are expected to eventually boost EV demand | Goldman Sachs
[35] EV100 - Progress and Insights Report 2023
[36] Some Companies Are Ahead in the Race to Reduce Emissions | BCG

Globally, governments are also leading the way by mandating the transition of departmental fleets to low and no emission energy solutions. For example, the UK has mandated that all new vehicles to be low or no-emission. The UK government aims to electrify their fleet of 40,000 vehicles by 2027[37]. The benefits of this for commercial operators in the UK are twofold: electrification of government vehicles provides a successful reference case that serves to enhance confidence in both the technological direction and the viability of transitioning for commercial operators, while also providing a strong business case for both the establishment of new business models (such as 'Truck-as-a-Service') and a ramp up of production of electric commercial vehicles by OEMs.

E-trucks from Foton (Source: Zung Fu Company)

Central to bolstering consumer confidence is ensuring that eMobility markets are designed with customer centricity in mind. Charging infrastructure, for example, should be available, reliable and easy to access and use (low friction). In 2021, the UK government acknowledged the critical role of EV drivers in the transition to eMobility and that reliable and easily accessible charging infrastructure is key to making the switch to EVs as easy and smooth as possible. A consultation paper with proposals on how to ensure that drivers of electric vehicles have a refuelling experience equal to or even better than petrol or diesel vehicle drivers was commissioned and published. The paper revealed expectations and ambitions across 4 critical areas[38]:

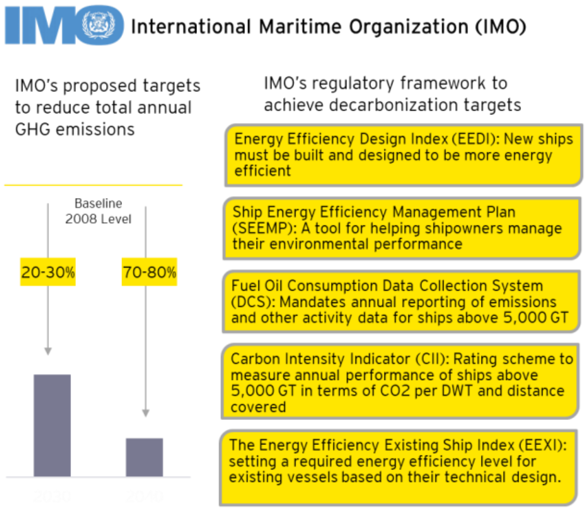
- **Making it easy to pay:** there should be a minimum standard for payment across all charge points, which does not only rely on the use of a smartphone.
- **Opening up charge point data:** All drivers should be able to locate available charge points easily when they need to charge their vehicle.
- **Using a single payment metric:** consumers should be able to understand and compare pricing offers across the UK network to select the best available price (e.g., £/kW).
- **Ensuring a reliable charging network:** The public charging network needs to be maintained and faults to be repaired quickly to ensure availability and reliability for consumers.

[37] Zero emission fleets: local authority toolkit - GOV.UK (www.gov.uk)

[38] The consumer experience at public chargepoints - GOV.UK (www.gov.uk)

Policies and incentives

In the maritime sector, the International Maritime Organisation (IMO), a United Nations (UN) specialised agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships, has established a regulatory framework aiming to reduce total annual greenhouse gas (GHG) emissions by 70-80% by 2040[39], using 2008 as the baseline year.



Source: OECD website, IMO website, DNV report, Hong Kong port website

There is also increasing support for the introduction of carbon taxes on vessel emissions. Early this year, the EU's Emissions Trading Scheme (EU ETS) was extended to cover emissions of all large ships[40], meaning that in 2025, shipping companies (including those operating in Hong Kong) will need to pay for 40% of their emissions reported in 2024, and in 2026 they will need to pay for 70% of their emissions from 2025.

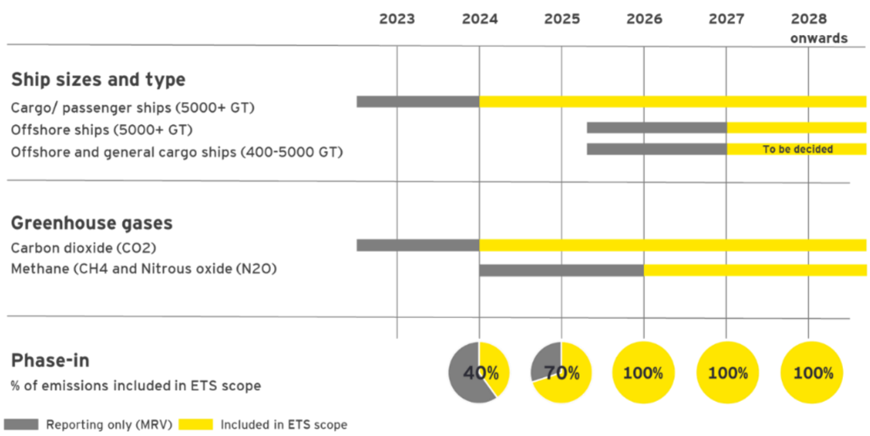
Furthermore, the FuelEU Maritime regulation sets mandatory targets for the greenhouse gas intensity of energy used by ships on a well-to-wake basis, meaning it accounts for the emissions across the entire fuel lifecycle, from production to consumption, covering a broader scope of emissions than the EU ETS.

These regulations have stimulated considerable investment by shipping companies in retrofit of existing ships and construction of new vessels to utilise alternative fuels such as LNG, ammonia and methanol while underway and to power systems using OPS while alongside in port. As might be expected, these shipping companies are indicating a preference for doing business through ports where alternative fuels and OPS are both available and competitively priced.

Several countries recognise that marine transport requires significant investment and coordinated support to decarbonise and are responding accordingly. The map on the next page is a summary of several global initiatives, predominantly focused on funding the construction and commissioning of new ferries and harbour fleet vessels, and typically target specific and highly visible use cases.

In Hong Kong, a similar approach is being adopted albeit on a smaller scale. The challenge in any case is ensuring that early funding is provided at sufficient scale to stimulate interest of OEMs in local markets. This is especially important in Hong Kong, where local and regional expertise in the

EU ETS introduction timeline



Source: *EU ETS – Emissions Trading System*

[39] 2023 IMO Strategy on Reduction of GHG Emissions from Ships

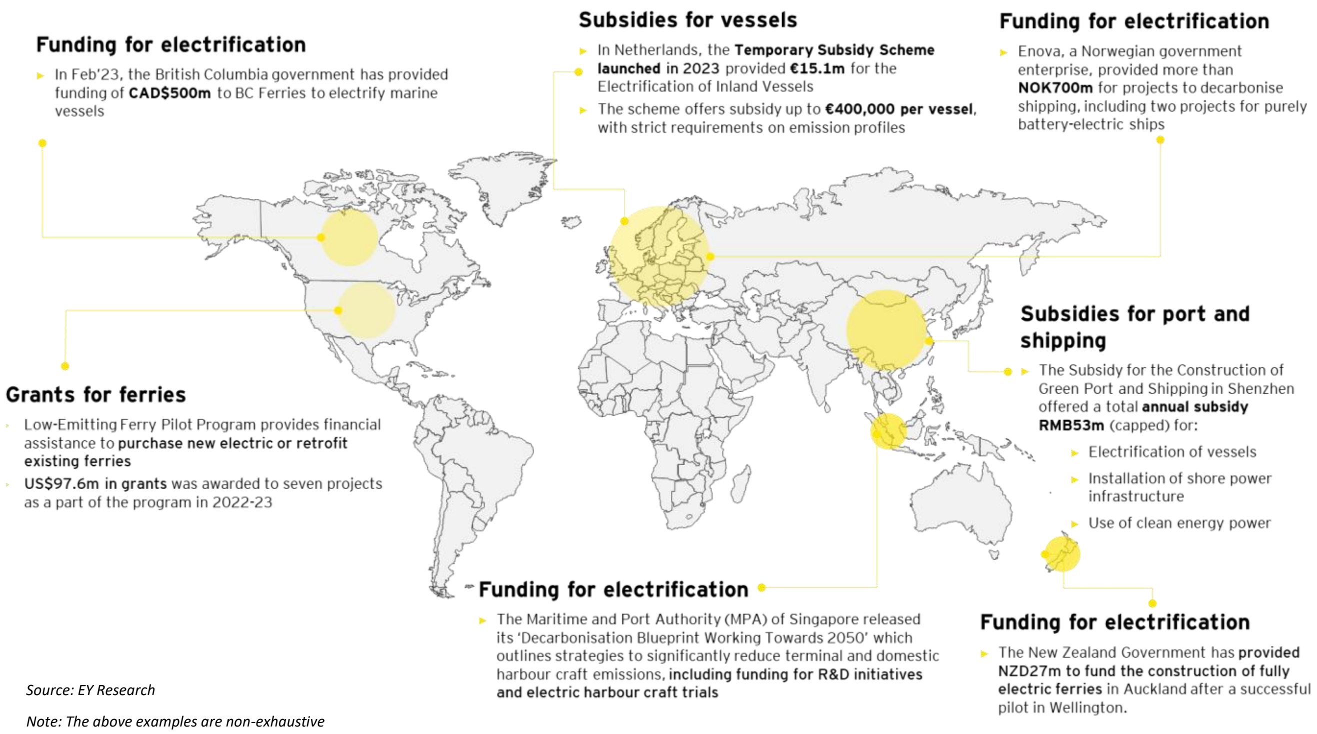
[40] Reducing emissions from the shipping sector - European Commission (europa.eu)

manufacture and maintenance of electric vessels is currently lacking, and availability of suitable vessels represents a significant constraint to broader uptake.

In the shipping industry, investment has been mostly focused on enabling infrastructure, such as the electrification of port and terminal operations, and the development of OPS and charging infrastructure. This is seen as both a necessary investment in decarbonisation and an economically beneficial one, given the potential to attract increased shipping activity and generate revenues through power supply to berthed ships and alternative fuel sales.

- In Mainland China, the government has provided subsidies for the construction and operation of shore power infrastructure across more than 400 berths. At some major ports, the Chinese government has also backed initial investments with further subsidies applied to the supply of power to ships connecting to OPS, providing an incentive to shipping companies to utilise the infrastructure.
Chinese Provincial governments also provide subsidies on shore power operation. Ports like Guangzhou offer a subsidy of US$0.015 per kilowatt-hour for shore power. Some provinces, like Shanghai, strictly enforce shore power usage and imposes penalties of around US$1,500 on ships that are equipped with shore power reception facilities but fail to use them while berthed[41]. Other provincial governments, like Shenzhen and Shandong, offer subsidies for retrofitting ships to use shore power[42].
- Early this year, the US Environmental Protection Agency (EPA) announced a US$3 billion Clean Ports Program to fund zero-emission equipment, infrastructure, and climate planning for US ports, including zero-emission cargo handling equipment, harbour craft and other vessels, electric charging and hydrogen fuelling infrastructure[43].

Global market players monetary initiatives



Source: EY Research

Note: The above examples are non-exhaustive

[41] Sustainable Ships
[42] 港口、船舶岸电设施和船用低硫油补贴初审受理条件、设定依据、申请材料、办理流程与办理地址? - 政策资金扶持 - 深圳市交通运输局（深圳市港务管理局） (sz.gov.cn)
[43] EPA invests $3B into clean ports | US EPA

Non-monetary incentives

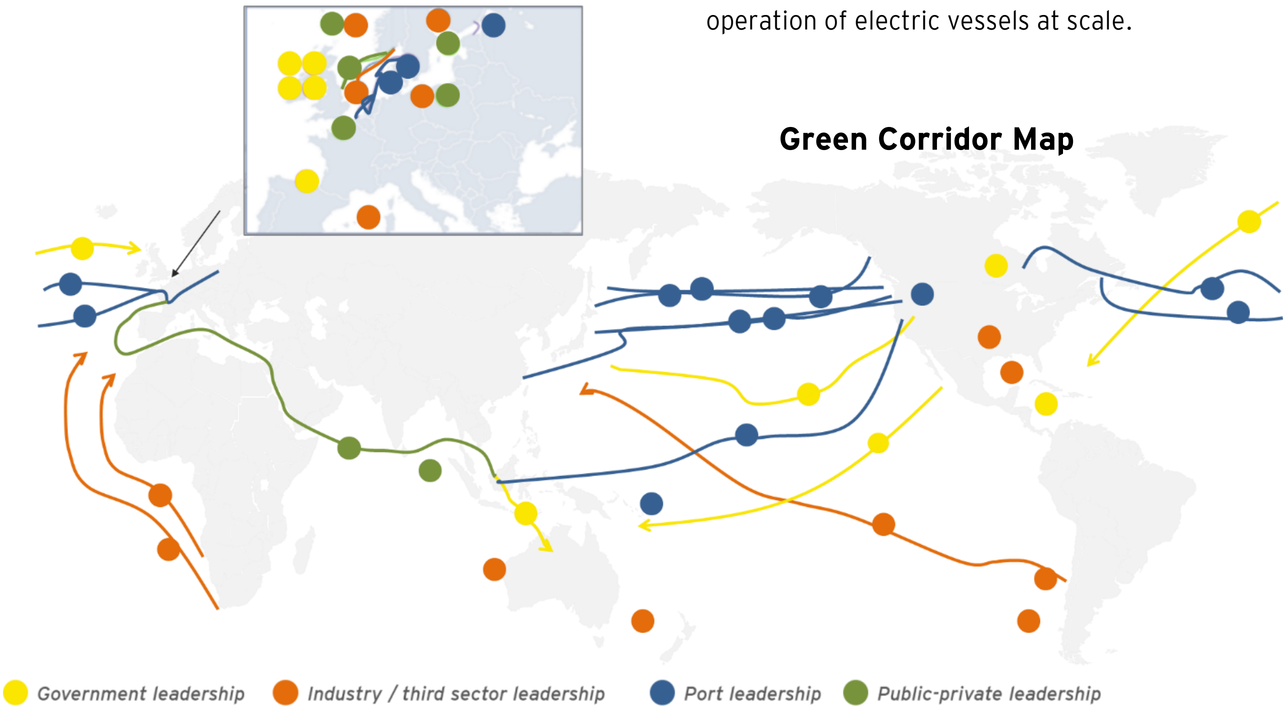
As developments in decarbonisation of the maritime sector are yet to reach the levels of maturity seen in land transport, examples of non-monetary incentives are limited. What is becoming apparent, however, is that the economic opportunities from increased shipping activity in combination with the social and health benefits of improved air quality for populations living in proximity to major ports provide a strong impetus for action with the right steer from policy makers.

While not an incentive per se, there are global examples of governments partnering with each other and with industry to establish green shipping corridors to foster new technologies and encourage transition to low and zero-carbon fuels. Such initiatives are often supported by shore power facilities at the Port at each end of the established corridor. An example of this is the green shipping corridor established between Shanghai and Los Angeles.

Charging infrastructure

In the maritime sector, numerous ports are signing shore power declarations to increase competitiveness and demonstrate their commitment to decarbonisation[44]. The sector already has established international standards for high-voltage power connections (IEC/ISO/IEEE 80005-1), ensuring compatibility between ships and OPS infrastructure. The main challenge is scaling implementation and uptake. In Hong Kong, decarbonising marine transport faces unique challenges compared to land transport, where vehicles are uniformly type-approved. Establishing an agreed-upon standard for charging applications is crucial for the marine sector's decarbonisation roadmap.

For ferries and harbour fleet vessels, the development of megawatt chargers has enabled fast charging of vessels with high range and power requirements[45], contributing to increased operational feasibility of electric vessel technology. Industry standardisation around charging connections across different vessel segments and use cases is still somewhat lacking however and is a key consideration in planning for uptake and operation of electric vessels at scale.



Source: Global maritime forum

[44] Overview of Ports' Sustainable & Shore Power Ambitions – Sustainable Ships (sustainable-ships.org)

[45] World's first maritime megawatt charging system in City of Sails | The Chartered Institute of Logistics and Transport (cilt.co.nz)

Battery swapping technology has emerged as a solution for vessels with power requirements and operational characteristics that make on-the-go charging unfeasible. COSCO Shipping recently commissioned two 700TEU fully electric cargo ships for operation along the Yangtze River in Mainland China, each with a 50,000 kWh battery capacity housed in easily removable and replaceable 20foot shipping containers. This modular design allows vessels to swap depleted batteries for fully charged units, overcoming limitations of charging time, load capacity, and cruising range[46].

This technology may be also viable for ferries and other vessels (subject to the vessel design, size etc.) with short turnaround times and longer-range requirements and provides a potential solution in locations where there is limited space for charging vessels directly, as the batteries can be removed to another location for charging.

Market (and consumer) confidence

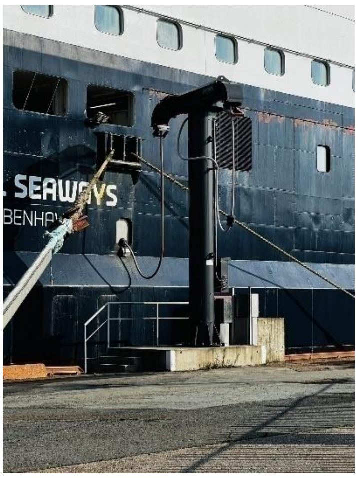
Some early adopters are starting to realise the longer-term financial benefits of electric vessel ownership, despite initially high capital costs. These benefits are being realised through reduced fuel costs and maintenance requirements and an overall lower total cost of ownership (TCO) compared with conventionally fuelled vessels. Operationally the development of battery technologies has enabled various classes of vessels to now be operationally feasible, with backup generators also present on e-vessels in the unlikely event of breakdowns.

A study in Denmark on the economic performance of pure electric versus diesel ferries found that electric vessels achieve cost parity with diesel powered ferries between 3.6 and 5.2 years[47], despite a higher initial capital cost of construction. These findings are being born out across operators of electric ferries globally, and there will be a significant first mover advantage for maritime transport operators in Hong Kong who are willing to invest in the future.

Ferries and harbour fleet vessels are increasingly focusing on electrification as technology advances.

Norway leads over 80 electric ferries in operation[48], while Singapore mandates that all harbour craft must be electric or use zero-carbon fuels by 2030. In Mainland China, provincial governments are also offering substantial subsidies to electrify inland cargo vessels, supported by advancements in battery swap technology.

Globally, cruise liners like Cunard, Norwegian, and Carnival are retrofitting shore power capability and identifying ports for infrastructure. In Asia, COSCO Shipping Lines, Orient Overseas Container Line, and COSCO Shipping Ports have jointly launched an initiative to promote shore power use by vessels at berth, facilitating decarbonisation in the maritime and port industry[49,50].



Shore power in Norway

Kongsberg Maritime autonomous electric cargo vessel for Norway's grocery distributor ASKO. Image © Kongsberg Maritime ASA, 2024

[46] Largest Electric, Battery-Powered Containerships Commissioned in China (maritime-executive.com)
[47] Evaluating the Economic Performance of a Pure Electric and Diesel Vessel: The Case of E-ferry in Denmark (researchgate.net)

[48] Norway showcases award-winning electric ferry technology (businessnorway.com)
[49] COSCO Shipping Ports Limited Annual Report 2023
[50] Initiative to Promote the Use of Shore Power by Vessels at Berth

E-tug in Lianyungang, Mainland China. (Source: CSSC)

Fully electric passenger ferry in Rotterdam. (source: Damen Shipyard and Purus)

Mobile shore power system in Yantian, China. (Source: Hutchison Ports)

Yara Birkeland is the world’s first fully electric and autonomous container vessel with zero emissions. Image © Kongsberg Maritime AS, 2024

Megawatt charger for passenger ferries in Norway

Mobile cable management system in Norway

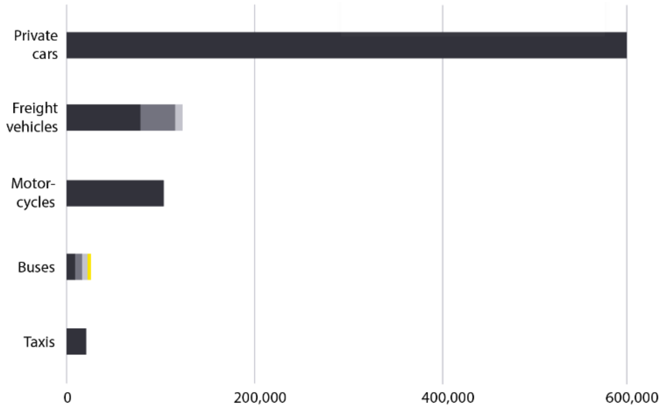
Transport sector as central enabler to decarbonisation strategy in Hong Kong

Globally, the road and maritime transportation sectors are well-known polluters and represent a significant opportunity to reduce carbon emissions. To continue to build on Hong Kong's leadership in significant public uptake of EVs in Hong Kong in recent years, more action would be prudent for Hong Kong to achieve its 2050 net zero ambitions, with transport as a key enabler. Commercial land and maritime fleets present an opportunity for Hong Kong, with decisions in investing in new fleet vehicles/vessels would have resulting impacts for the next 15-25 years.

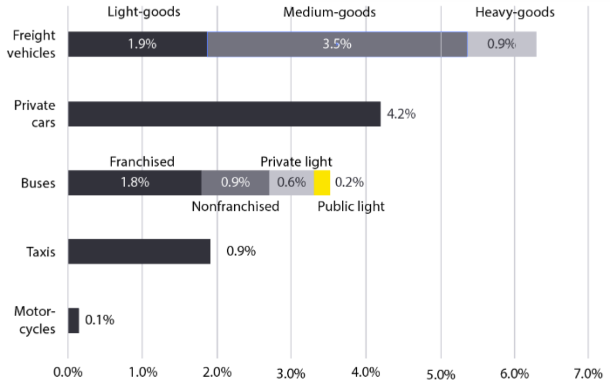
In 2022 in Hong Kong, road transport accounted for approximately 18% of total CO_2 emissions, making it the second largest emitter[51]. It is also a major emission source of Volatile Organic Compounds (VOC) and Carbon Monoxide (CO) Emissions, accounting for 49% of total CO emissions[52]. In 2021, road transport accounted for 19% of total Nitrogen Oxide (NOx) emissions compared with just 16% in 2019. Emissions from commercial vehicles and buses are disproportionately higher on a per vehicle basis compared with private vehicles, by a large margin.

As Hong Kong's efficient and robust public transportation delivered 9.7 million passenger journeys in 2022, serving 90% of total journeys[53], and given progress made in private uptake of EVs, the opportunity for decarbonisation revolves around the transition of trucks and buses which also represent the majority of air pollution emissions in Hong Kong, making up 81% of NOx emissions[54] despite representing only 19% of the total vehicles on the road[55].

Total Road Registered Fleet in Hong



Proportion of greenhouse gas emissions in Hong Kong's total emissions



Source: HK-transport_Final_20220930.pdf (civic-exchange.org)

[51] HK CO2 Emissions - Data Tables_2022
[52] 2021_Emission_Inventory_Report_Eng_Revision
[53] Transport Department - Introduction
[54] enb-e.pdf (legco.gov.hk)
[55] Transport Department - December 2023

The maritime sector is also a major pollution source in Hong Kong (including those produce by landside terminal operations). Maritime transport accounts for more than a quarter of total emissions of key air pollutants[56]. With significant reductions in emissions from the electricity and road transport sectors in recent years, marine emissions have now become the predominant source of emissions in Hong Kong[57]. The impact is even greater if taking a well-to-wake approach in assessing emissions intensity[58].

In total, there are around 21,000 licensed vessels across the four vessel classes established in Hong Kong. The majority of vessel emissions in Hong Kong come from ocean-going vessels calling at the port, accounting for 40-90% of total vessels emissions[59]. This is followed by local vessels, primarily Class 1 & 2 vessels, which are the focus of this report. Class 3 & 4 vessels have fragmented ownership structures and will require Class I & 2 vessels to pave the way, and hence have been omitted from the study of this report.

This high level of emissions is partly due to the absence of shore power, alternative fuels, and charging infrastructure in Hong Kong, which leads to the burning of conventional fuels while ships are at berth[60]. Additionally, there has been insufficient local investment in alternatively powered vessels and the necessary supporting infrastructure.

Passenger ferry (Class I, source: Sun Ferry)

Pilot Boats (Class II)

Fishing vessels (Class III)

Yacht (Class IV)

Vessel classification in Hong Kong

Class I - Gov / commercial ferries

e.g. Ferries vessel, launches

- Mainly used for transporting passengers from one place to another within Hong Kong waters, such as ferries.
- Routes are highly scheduled, with such a predictable operating profile, this assists in charging and sizing marine batteries

Class II - Work vessels

e.g. Tugs, workboats, pilot boats

- Mainly used for the transportation of cargo or performing work at sea, such as dangerous goods carriers and tugs. The size and construction complexity of a Class II local vessel depend on its purposes.
- Class II are generally high-powered vessels and essential for port operations, resulting in high emissions by sector. Electrification will greatly contribute to reducing emissions in the port

Class III - Fishing vessels

e.g. Fish sampan, outboard open sampan,

- Used exclusively for fishing and related purposes, power demand comparable to Electric Vehicles, resulting in low technical barriers.
- Large proportion of the Hong Kong fishing fleet, fishes within territorial waters. Such limited range makes adoption of electrification feasible.
- Electrified operations reduces noise and vibration from the boat, making larger catches of fishes more feasible.

Class IV - Pleasure vessels

e.g. Yacht, cruiser

- Exclusively used for pleasure purposes such as cruising, fishing or watersports
- Various types of Class IV vessels found in Hong Kong waters, quiet non-polluting electrified experience is preferable for such pleasure activities.
- Short operating range, low power demand makes electrification achievable

Source: Statistics on Hong Kong Licensed Vessels

[56] 2019 Emission Inventory Report_Eng.pdf
[57] 2019 Emission Inventory Report_Eng.pdf (epd.gov.hk)
[58] Global Shipping Emissions from a Well-to-Wake Perspective: The MariTEAM Model
[59] Hong Kong's Clean Air Plan 2035
[60] Hong Kong Pulls Plug on Cruise Terminal Shore Power System

Climate, social and health and economic impacts

Higher temperatures and increased frequency of extreme weather events in Hong Kong are but two examples of the ongoing consequences of delayed global action to reduce global carbon emissions[61]. Given the localised nature of these specific impacts, it is becoming increasingly clear that more forthcoming action is necessary and that Hong Kong has strong incentives, both environmental and economical, to take on a leading role in the global effort to decarbonise.

Hong Kong's sustainability challenges

Extreme heat and heavy rainstorms	2023 was the second warmest year on record with an annual average temperature 25.5°C, as well as the once-in-century wettest Typhoon Haikui which caused damage to infrastructure, disrupted transportation, impacted businesses as well as power and water supply, leading to an average HK$3.3 – 6.6 billion economic losses[62].
Air, noise and environmental pollution	Despite nominal improvements in Hong Kong's air quality since 2021[63], significant challenges remain in enhancing air quality and lowering carbon emissions across land transportation, as the second largest contributor to carbon emissions. Marine vessels and shipping, as another major source of air pollutants in Hong Kong[64], also continue to impact environmental and public health. These emissions continue to exacerbate climate change effects such as rising temperatures and the frequency and severity of extreme weather events, while also degrading air quality, leading to respiratory problems, cardiovascular diseases and other health issues among the population[65].
Biodiversity impacts	Warming climate, pollution and emissions are critical factors in determining the preservation or loss of biodiversity[66]. In 2021, the Hong Kong bird watching society released its *"Hong Kong Biodiversity and Conservation 10-year Review"* and found that Hong Kong missed 14 out of 20 global biodiversity targets[67]; revealing the urgent need for the city to tackle climate change and pollution or risk losing Hong Kong's unique status as a bustling city with impressive natural habitats and biodiversity.
Economic impacts	In the global economy, countries and cities compete for business and talent, and with corporations increasingly considering ESG impacts in their growth plans, a conducive business environment that offers affordable decarbonisation is crucial to Hong Kong's economic prosperity[68]. One industry stakeholder highlighted that global corporate funds for fleet decarbonisation are allocated based on local business cases, emphasising the importance of the green economy for continuous investment in Hong Kong. Hong Kong Port, historically among the busiest in the world, faces challenges as shipping companies invest in technologies to reduce carbon emissions due to increasing support for carbon taxes and regulatory signals from key regulators like IMO. The availability and price of shore power and alternative fuels are now key considerations for shipping companies deciding where to do business. The effect on Hong Kong Port is evident, with a significant reduction in cargo throughput resulting in downstream economic impacts. As new ships are built to run on alternative fuels and use OPS, the availability of competitively priced shore power and alternative fuels will become increasingly crucial for the success of Hong Kong Port and the broader economy. Given its unique geography and impressive public transport network, Hong Kong has an opportunity to lead in demonstrating the benefits of transport decarbonisation. A world-class eMobility ecosystem presents an exciting opportunity to advance smart city development, reduce air pollution, and improve the quality of life for Hong Kong citizen.

[61] Climate Change Leads to More Extreme Weather, but Early Warnings Save Lives, UNFCCC
[62] Hong Kong issues No 1 typhoon warning as Haikui nears; billions of dollars in economic losses estimated from Saola | South China Morning Post
[63] Hong Kong's air quality in 2023
[64] 2021 Emission Inventory Report
[65] Electrifying Heavy-Duty Vehicles Will Benefit the U.S. Economy, Environment, and Public Health - Electrifying Heavy-Duty Vehicles Will Benefit the U.S. Economy, Environment, and Public Health - United States Joint Economic Committee (senate.gov)
[66] Hong Kong must tackle the biodiversity and climate crises together | WWF Hong Kong
[67] HKBWS's latest report reveals Hong Kong misses 14 out of 20 global biodiversity targets - Hong Kong Bird Watching Society
[68] Cities Competing for Talent in the Global Economy

Hong Kong's decarbonisation commitments

In alignment with China's national objective of achieving carbon neutrality by 2060, Hong Kong has pledged to achieve carbon neutrality by 2050, setting an intermediate goal to reduce carbon emissions by 50% by 2035 relative to 2005 level, as outlined in the city's Climate Action Plan 2050 (CAP 2050)[69]. It outlines key action items across four key areas: Net zero electricity generation, energy saving and green buildings, green transport (land and marine) and waste reduction. The Hong Kong government also issued the Clean Air Plan for Hong Kong 2035 to reduce air pollutants, which supports Hong Kong's vision of 'Zero Carbon emissions · Clean Air · Smart City'.

[69] Government announces Hong Kong's Climate Action Plan 2050

In 2021, the Hong Kong government released its Roadmap on the Popularisation of Electric Vehicles, providing a clear signal to the Hong Kong market of its ambition to decarbonise the transport sector. Uptake of EVs has been accelerating in recent years, with 70% of private car sales being EVs in 2024[70], resulting in now nearly 90,000 EVs on the road in Hong Kong as of March 2024[71], this signal to the market has proven to be effective.

Hong Kong's key initiatives aimed at promoting green transportation across EVs and other new energy transport options (such as hydrogen) include:

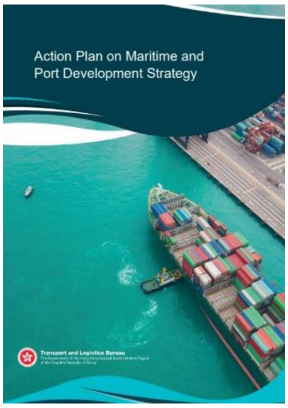
- Planning to cease the registration of new fuel-propelled and hybrid private cars by 2035 or sooner.
- HK$300 million scheme for the private sector to install quick charging facilities, targeting 3,000 quick chargers to be installed by 2030.
- Expansion and development of a public and private charging network, including the provision of the EV-charging at Home Subsidy Scheme (EHSS), which offers a total funding of HK$3.5 billion[72] to deliver 200,000 total EV charging points across Hong Kong by 2027.
- HK$ 750 million under the new energy transport fund to conduct trials. As well as aim to place around 700 electric buses and 3,000 e-taxis on the road by 2027[73,74].
- Hydrogen could play a role in decarbonisation of heavy-duty commercial goods vehicles. However, hydrogen energy is still in the early stages of development internationally, and the scale and speed of its future development will depend on whether it proves to be more cost-effective than other green and low-carbon technologies[75].
- Current pilot projects for hydrogen fuels are being initiated for hydrogen fuel cell electric buses and heavy-duty vehicles. The government has allocated HK$200 million to subsidise the procurement and operation of hydrogen fuel cell vehicles, and installation of refuelling facilities[76].

In view of these initiatives, Hong Kong has experienced a significant increase in the adoption of electric vehicles in recent years. At of the end of June 2024, the total number of EVs represents about 9.7% of the total number of vehicles[77], with just over 8,700 public EV chargers now installed across all 18 districts, including 5,234 medium chargers and 1,511 fast chargers[78].

While progress has been significant in the uptake of electric private vehicles, the commercial vehicle segment has lagged and requires more attention moving forward to accelerate transition and address the disproportionate share of carbon emissions that these vehicles represent.

[70] LCQ20: Introduction of China-made plug-in hybrid electric vehicles (info.gov.hk)
[71] Promotion of Electric Vehicles | Environmental Protection Department
[72] The EV-charging at Home Subsidy Scheme (evhomecharging.gov.hk)
[73] LCQ18: Electric public transport (info.gov.hk)
[74] Policy Address | The Chief Executive's 2024 Policy Address
[75] strategy-of-hydrogen-development-in-hong-kong_booklet_en.pdf (cnsd.gov.hk)
[76] Legislative Council Meeting Motion Debate on "Promoting the development of green transport"
[77] Promotion of Electric Vehicles | Environmental Protection Department
[78] EV makers swarm to Hong Kong, lured by strong Government support, rapid adoption rate | South China Morning Post

In the Maritime Sector, the Hong Kong government publicised its action plan in the Maritime and Port Development Strategy, which includes one of its ten strategies aimed at developing Hong Kong as a Green Shipping Hub[79].



The first milestone along this path involves the planned development of a high-quality green fuel bunkering centre, intended to provide shipping companies with the access to alternative fuels when calling at Hong Kong Port and enhancing its attractiveness along international trade routes[80]. Hong Kong has also introduced the world's first CII-related Green Incentive scheme, where ships above 5,000 gross tonnage which attained rating A or B in the CII formulated by the IMO are eligible for a green incentive[81]. Also, the Marine Department has recently revised the Codes of Practice to include a new chapter on "Special Requirements for Battery Powered Vessels"[82]. Furthermore, the Hong Kong Government in its 2024 policy address looks to promote port emissions reduction and construct a green shipping corridor with major trading partners.

In addition, the government has earmarked HK$350 million to provide subsidies for the construction and trial of four electric passenger ferries and associated charging facilities for several in-harbour routes, with delivery of the first of these expected in 2024[83]. A vessel subsidy scheme (VSS) to subsidise the outlying island routes has also been introduced, with the 14 of 22 ferries expected to start operation in 2024[84].

Hong Kong has taken significant first steps in a long journey towards decarbonisation, yet overcoming a variety of challenges, particularly clear policy direction and timely deployment of charging infrastructure will be crucial in continuing the momentum in marine transport.

Addressing these challenges will be essential for Hong Kong to achieve its 2050 ambition. Especially given long lead times for the construction of new zero-carbon vessels and deployment of refuelling or charging infrastructure required to support them.

[79] Action Plan on Maritime and Port Development Strategy (hksoa.org)
[80] Hong Kong to inject tens of millions to turn city into Green Shipping Hub
[81] news.gov.hk - Hong Kong embraces green shipping
[82] Codes of Practice - Marine Department (mardep.gov.hk)
[83] news.gov.hk - Govt preparing for electric ferries
[84] news.gov.hk - 3 subsidised new ships arrive

Call for action

Despite significant growth in the sale of EVs among individual buyers in recent years, and the mandated use of low-sulphur fuels by ocean going vessels while operating within the Port limits, this is just the beginning of the city's decarbonisation journey. Many commercial market players in Hong Kong, across both land and marine sectors, have yet to make significant investments in decarbonisation. Given the economic concerns around these key decisions and no clear firm policy signals and guidance, an accelerated pace is required for Hong Kong to achieve its decarbonisation ambitions without significant coordinated effort among all ecosystem stakeholders.

In leading decarbonisation markets, organised and effective partnerships are recognised as a key factor for achieving efficient transition to decarbonisation. In Norway, for example, the Green Coastal Shipping Programme (GCSP) was initiated by engaging Norway's entire shipping cluster, to facilitate the implementation of green technologies and solutions involving collaboration between government, utilities and key industry players. As of 2023, the GCSP comprised 94 private companies and organisations having initiated 45 green pilot projects of which 17 have progressed to further development.

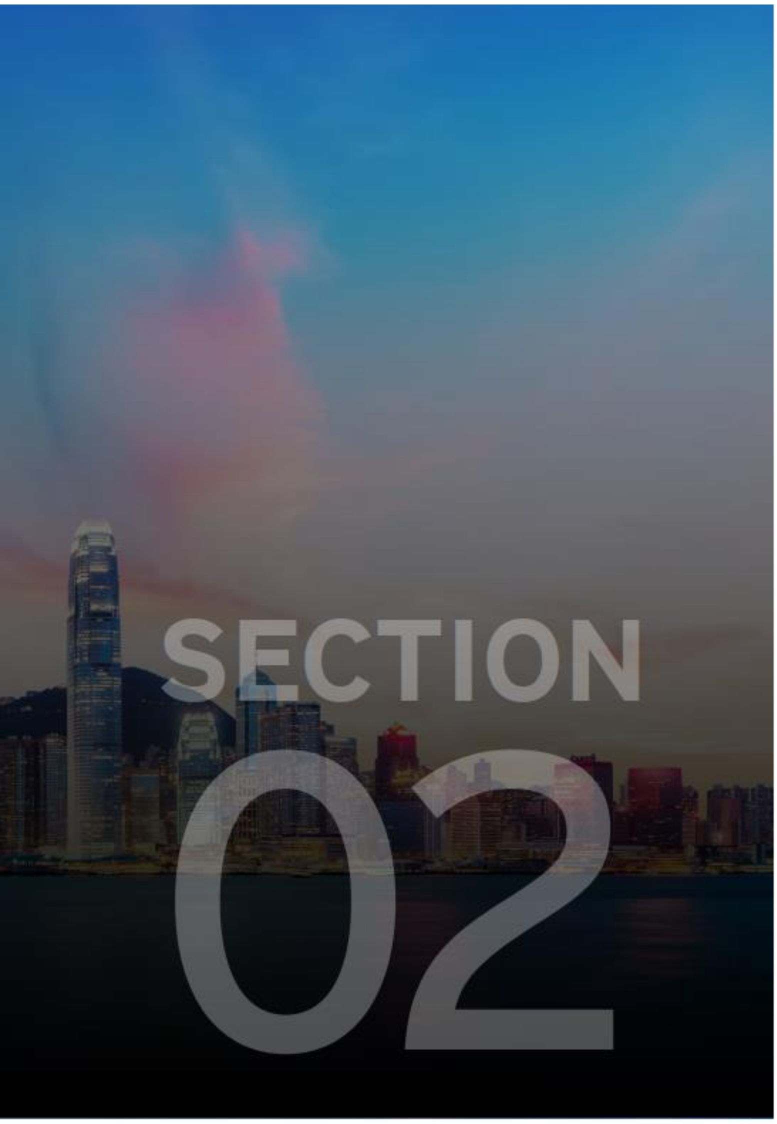
In the land transport sector, Elaadnl was established by the Netherland's grid operators to conduct research & development on innovative smart charging solutions. They collaborate with municipalities and private players alike to gather data and share research findings to accelerate smart charging implementation[85]. On the business development side, Comdata and Hubject have partnered to enhance EV charging and payment solutions across North America[86].

While different markets are travelling on their own technology pathways towards decarbonisation, strategic choices must be made by assessing the 'Speed and Scale' of technology, 'Availability of Fuel', 'Transition Cost' and 'Consumer Confidence'. We assess intricacies of technology options and applicability to Hong Kong in the next section.

Hong Kong is uniquely positioned to become a leader in transport decarbonisation, leveraging its dense urban environment, advanced public transport system and strategic port facilities. However, achieving this will require the next set of policy decisions, significant investment in infrastructure and strong collaboration between public and private sectors to accelerate land commercial and harbour fleet transition as well as develop a green shipping hub through investment in shore power and alternative fuels.

[85] About us • ElaadNL

[86] Comdata Expands Partnership with Hubject



What alternative fuel options does Hong Kong have and which segments make most sense for electrification?

Pathways to decarbonisation

Section 2: Pathways to decarbonisation – Key takeaways

Globally, the transition to green land transportation has revolved around electrification and hydrogen. Currently, the majority consensus indicates that electrification is likely to form the backbone of future zero-emission mobility, with hydrogen supplementing for specific high payload, high range uses cases. However, it is also clear that a multi-pronged approach will be required to achieve net-zero 2050.

1

Alternative fuels:

- Given the relatively low range requirements in Hong Kong, electrification presents a unique opportunity to decarbonise transport amongst commercial vehicle and bus segments in both the short and medium term (2035).
- The case for using hydrogen for heavy vehicle segments, such as HGVs will likely improve in the medium to long term as affordable green hydrogen becomes more readily available.
- However, it is critical for Hong Kong to maintain momentum in its decarbonisation journey now to avoid delays in meeting net-zero goals.

2

Total cost of ownership:

- Certain segments such as LGVs already offer a 43% improvement in TCO in Hong Kong and making a strong case for transitioning to electric. Other heavier segments such as MGVs & HGVs are close to cost parity. In all cases, the high upfront cost of EVs compared to their ICE equivalents remains a barrier.

3

Charging Infrastructure Needs:

- Approximately 200,000 chargers will be required by 2030 to support the projected EV uptake necessary for Hong Kong to achieve its 2050 net-zero goal.
- Significant initial foundational steps have been taken to improve 'Home' and 'Workplace' chargers, which typically cater towards private car segment. However, more 'Public-on-the-go' and 'Destination' chargers are required to facilitate the adoption of commercial vehicles and public transportation.

Section 2: Pathways to decarbonisation – Key takeaways

The Maritime sector's decarbonisation journey is more complex than Land, with many alternative fuel options requiring substantial investment. Electrification, however, offers both operational feasibility and sustainability benefits, justifying the investment required and representing an immediately viable option. This report focuses on Class I and II vessels, as these commercial vessels collectively represent the largest share of harbour vessel emissions in Hong Kong, and their successful transition will pave the way for other vessels to follow.

1 Alternative fuels:

- Both Electrification and Methanol provides the most rapid decarbonisation potential in the short and medium term (up to 2035) for both Class I & II vessels. However, electrification has the advantage of a readily available supply to enable the transition.
- The continuous planned phase-out of coal-fired plants and increased usage of low carbon energy share in Hong Kong will continue to reduce grid emissions, thereby strengthening the case for electrification in the medium term.

2 Total cost of ownership:

- While the TCO margin between conventional ICE and electric ferries is narrow, high-level analysis still indicates a net positive benefit in electrification over the useful life of the asset. This benefit increases for smaller vessels, which are less costly and complex to design and construct.

3 Charging Infrastructure Needs:

- From a broader economical and sustainability perspective, the development of OPS for use by ocean going vessels represents a significant opportunity for Hong Kong. According to EY teams estimate (based on current annual cargo volumes) approximately 200 kilotons of carbon could be saved annually by 2050 if OPS were available and fully utilised by ships calling at Hong Kong Port.
- Based on the "Moderate" uptake scenario, approximately 250+ chargers would be required to meet the charging needs of 550+ e-vessels in 2050. In practice, a portion could be offset through adoption of battery swap technology, which will also address space constraints and the operational needs of high-use vessels with low turnaround times. In any case, a phased approach will be prudent for the incremental and sustainable development of charging infrastructure in line with anticipated demand.
- In planning and developing the required infrastructure, the significant diversity in vessel types, use cases, and operational profiles within classes and sub-segments means that stakeholders will need to be collectively consulted. Infrastructure development should be undertaken with a high level of coordination to make best use of the limited space available for the installation of chargers.

2. Alternative fuels are on the rise

There are many promising fuel options and technologies for decarbonisation, and global experience indicates that most jurisdictions will likely adopt a multi-pronged approach. According to the European Commission's 2050 Long-term Climate Strategy, there is no single fuel solution for the future of low-emission mobility – all alternative fuel options are likely to be required, but to a different extent across different modes of transport[87].

While technically true, it's important for Hong Kong to evaluate different fuels and technologies in the context of its unique circumstances and needs, providing clear direction to support those fuels and technologies that are deemed most suitable. The benefits of doing so are twofold: Infrastructure planning and investment decisions can be made based on a common understanding of what needs to be achieved, and the private sector can respond accordingly, investing with confidence that the infrastructure and fuel or power to support their transition will be available and supported over the long-term.

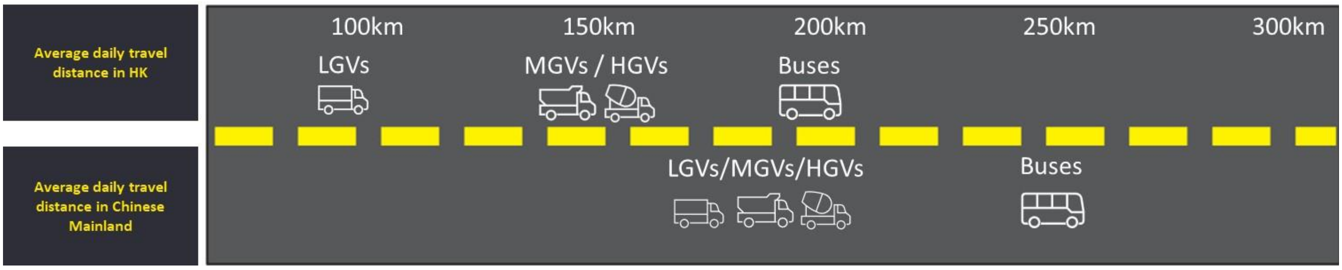
Global trends will, however, remain important as they dictate the rate of advancement of different technologies and, to some extent, the reliability of supply chains.

[87] European Alternative Fuels Observatory

The operational requirements for commercial vehicles vary broadly across different vehicle segments and use cases, and the industry is pursuing several different options for decarbonisation. Electric Power, Hydrogen, Compressed Natural Gas (CNG) and LNG are all proving viable options, though electric is currently leading the way. Bloomberg predicts that EVs will account for 56% of all light goods vehicle sales and 31% of medium goods vehicle sales in Mainland China, US, and Europe by 2040[88]. There remains an ongoing debate, however, about the most suitable technology pathway for a sub-segment of heavier-duty applications[89], where high payload capacity and range requirements may make electric a less viable option. While payload and range concerns are certainly valid, research shows that most available zero-emission HGV are now able to drive between 160-480km with a gross train weight of 40-44 tonnes[90,91] and have now largely conquered concerns around operational range requirements. The extreme long-haul duty cycles however, are still challenging to meet with current existing technology[92].

Despite this challenge, advances in latest battery and charging technology suggest that this range can be extended by up to 600km with only 10 minutes charging time and can achieve 1,000 km on full charge[93]. For heavy duty vehicle operations in and around Hong Kong, this would satisfy the requirements of most use cases. The table below shows the average daily travel distances across different commercial vehicles segments in Hong Kong[94]. Range capabilities published by OEMs indicate that on a purely technological basis, all of these vehicle segments are viable for electrification in Hong Kong.

Average daily travel distances in Hong Kong and Chinese Mainland



Case Study: A global innovative and sustainable leader bets on EVs

In a deal with Volvo, a global leader in innovative and sustainable building solutions, has placed an order for 1,000 electric trucks, which will be deployed across Europe.

Key Takeaway: Global fleet operators are indicating confidence in EV technology, with some investing heavily in the transition. Given the relative ease of translation of advances in private EVs to commercial models and applications, it is likely that current trends will continue.

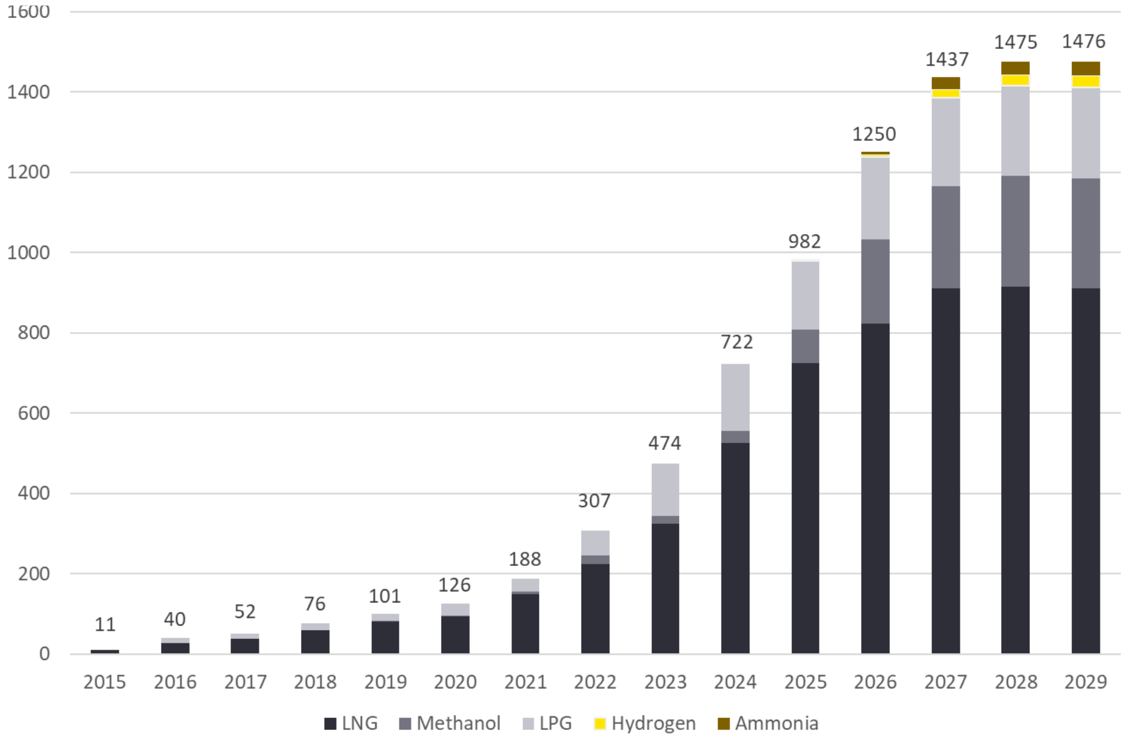
Source: A global leader in sustainable building solutions orders 1,000 Volvo trucks

[88] BloomergNEF Electric Vehicle Outlook 2024
[89] Alternative fuels for heavy-duty off-road applications are ready now
[90] eActros 600 | Mercedes-Benz Trucks (mercedes-benz-trucks.com)
[91] Electric trucks have a range of up to 400 km | Scania Group
[92] Global-Roadmap-for-Reaching-100-Zero-Emission-Medium-and-Heavy-Duty-Vehicles-by-2040_63022.pdf (globaldrivetozero.org)
[93] China's Gotion breaks 10-minute charge barrier in EV battery race - Nikkei Asia
[94] Transport Department Survey on Goods Vehicle Trip Characteristics Final Report 2011

The maritime industry is actively pursuing various approaches to decarbonisation, with options diverging significantly across different vessel segments. Due to range and payload requirements, LNG powered ocean going vessels currently represent around 70% of the 2024 order book. However, orders show that trends in the medium to long term are shifting towards adoption of alternative fuels such as methanol, with hydrogen and ammonia at a smaller scale; orders for LNG fuelled vessels are increasing in the short term but expected to plateau in the medium to long term. In addition to vessels capable of using alternative fuels, 433 vessels on order will feature battery or hybrid power systems as of June 2024[95]. The Hong Kong government's Action Plan on Maritime and Port Development Strategy includes methanol as potential alternative fuels to replace existing marine petroleum fuels to achieve zero carbon emissions[96]. In contrast, electrification is emerging as the preferred option for decarbonisation of domestic harbour craft, particularly in regions where power supply and infrastructure are already well developed and reliable.

"In service" alternative fuel ship trend

Cumulative number of ships delivered since 2015, without considering scrapping



Note: 1. Chart repurposed from ClassNKAlternativeFuelsInsight | 2. As at the end of June 2024 (Orderbook is included after 2024) | 3. 5,000 gross tonnage and above | 4. LNG carriers are excluded from LNG fueled ships | 5. Alternative fuel ready ships are not included

The world's first LNG-powered bulk carrier. (Source: CSSC)

Ro-Ro passenger vessel powered by LNG-fuel oil dual-fuel engine. (Source: CSSC)

95 Maritime Forecast to 2050
96 Legislative Council Panel on Economic Development Action Plan on Maritime and Port Development Strategy 2024

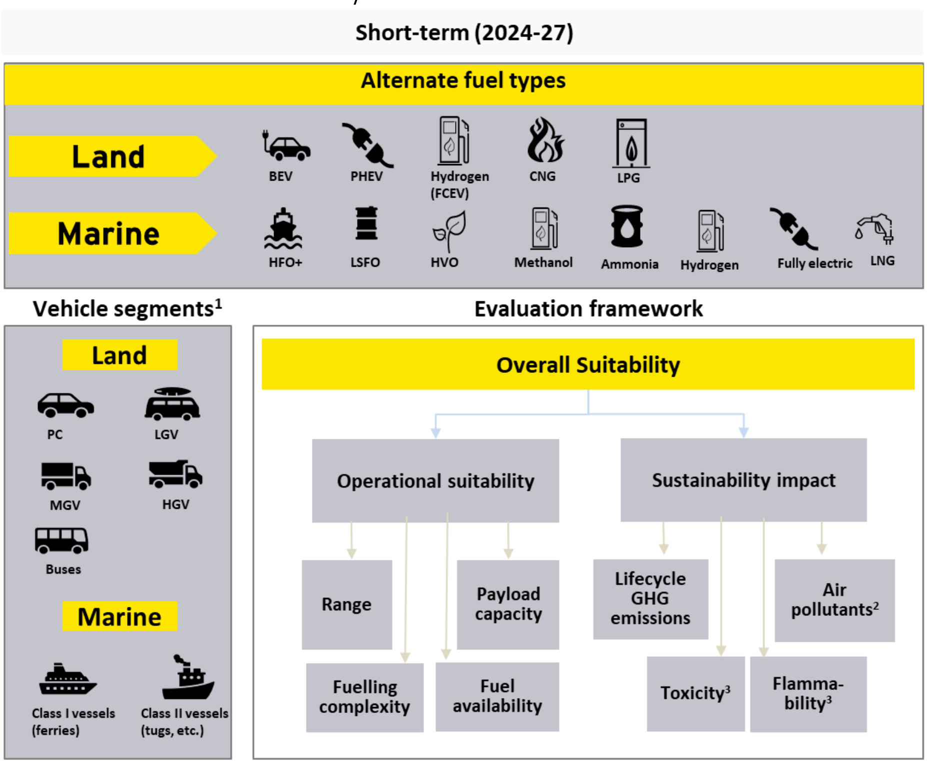
Evaluation of energy options for Hong Kong

While different countries and regions are each following their own paths to decarbonisation, several key factors are driving decision-making, which will be vital for Hong Kong to consider for an effective and scalable transition across different vehicle and vessel segments. These factors include the maturity of the technology and expected advancements, availability of fuel, cost of transition, sustainability impact and others. As such, EY team have conducted an indicative alternative fuels technology analysis to determine which fuel options are most suitable for Hong Kong. Our assessment focused on the 2024-2027 horizon, based on the following assumptions:

- The current electricity mix which is (natural gas ~ half, zero carbon nuclear/renewables ~one-third and the rest coal).
- Vehicle/ vessel efficiency and payload are determined based on the specifications of select common models available in the market today.
- Fuelling complexity and Fuel availability parameters are evaluated by considering the current challenges faced by market participants.
- Prevalent fuel and fuelling infrastructure costs are considered.

In addition to the short-term outlook, EY team has also provided some high-level considerations for the anticipated evolution of energy options by 2035 in the following sections. The analysis covered 5 vehicle segments in land transport and 2 vessel classes in marine transport, based on two primary parameters:

1) ***Operational suitability*** is determined by considering alternate fuel asset range, payload capacity, fuelling complexity (including enabling cost and infrastructure) and availability of each fuel type.
2) ***Sustainability impact*** is assessed by evaluating the emissions reduction potential and safety of alternative fuels



*Notes: 1. Refer to notes for acronyms I 2. Other pollutants include PM2.5, NOx and SOx emissions I 3. Applicable only for marine transport
The suitability analysis is performed based on the current view and does not provide a futuristic view I BEV, hydrogen and ammonia considered in the analysis are based on the current electricity mix
CNG – Compressed Natural Gas | LPG – Liquified Petroleum Gas

BEVs have emerged as the most suitable option overall across all vehicle segments at present and in the short-term. They are followed by Hydrogen Fuel Cell Electric Vehicles (FCEVs), which are expected to improve in operational suitability and sustainability for Heavy Good Vehicles (HGV).

The key factors contributing the outcomes are as follows:

- There are around 8,700 public charging stations in Hong Kong, more than any other alternative fuels;
- The relative ease and low cost of scaling existing infrastructure over establishing new supply chains and infrastructure (EV charging stations range from USD $15K to $100K, compared to USD$1-2M for hydrogen stations);
- BEVs in Hong Kong are expected to have on average 53% lower lifecycle emissions compared with ICE vehicles, in line with the International Council on Clean Transportation's (ICCT) average global estimates of up to 63% GHG emissions savings.
- Hong Kong's limited geography offers unique opportunities in decarbonisation, as typical daily ranges (around 70km-220km) of commercial truck vehicles fall well within the capabilities of BEVs.

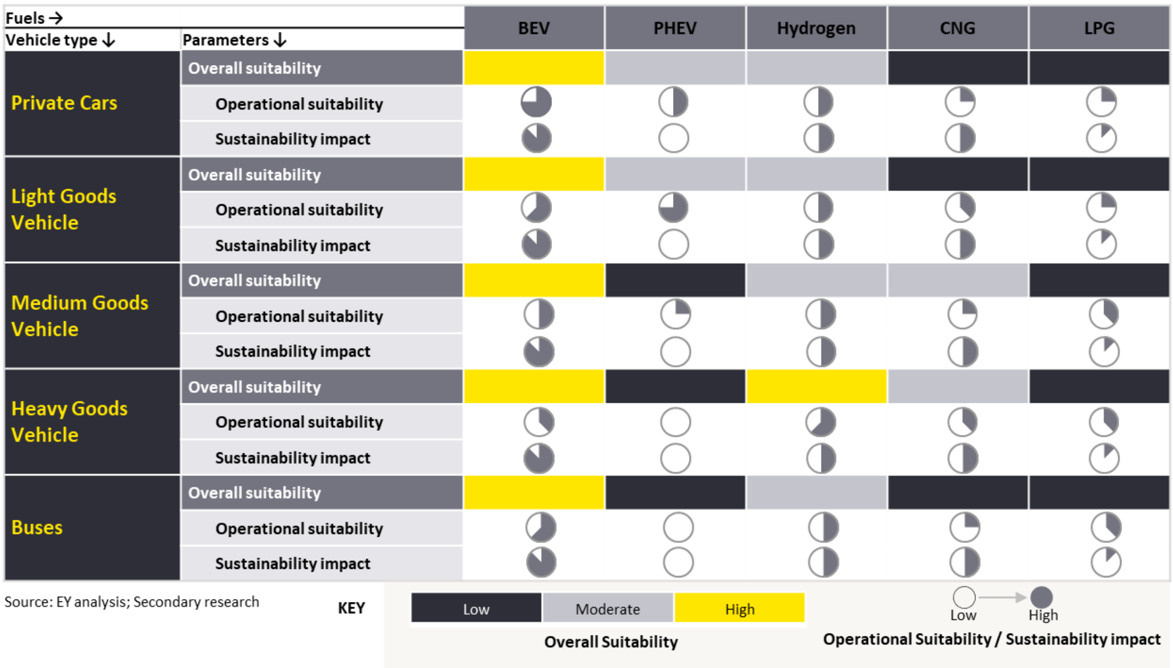
For MGVs and Buses, BEVs are the most suitable alternative fuel technology, driven by fuel availability, sufficient range (200-300 km) to meet daily average travel needs (around 140-250 km) and lower GHG emissions.

For HGVs, hydrogen is also emerging as an operationally suitable option, having payload capacity and vehicle range comparable to that of ICE vehicles.

However, the current production of hydrogen from natural gas limits its sustainability potential. At present, majority of hydrogen utilised in Hong Kong is categorised as grey hydrogen and is produced using fossil fuels. It is also expensive to produce and distribute, with a heavy reliance on imports from Mainland China. The poor economics are further exacerbated when considering the production of green hydrogen[97].

Electrification is emerging as the most suitable option to decarbonise land transport in Hong Kong, with hydrogen potentially to be considered select use cases of HGVs.

Fuel technology suitability assessment in Hong Kong (2024-2027)



Source: EY analysis; Secondary research

97 [High gas prices triple the cost of hydrogen production | articles | ING Think]

In the maritime space, EY team's analysis indicates that fully electric powertrains, with the lower well to wake emissions (zero emissions at the vessel level) and lower safety risks, are identified as the most sustainable and secure option for both Class I & II vessels.

Fully electric vessels offer a simplified fuelling process, with reduced risks of toxic fumes and combustion, therefore minimising concerns related to storage and handling.

For Class II vessels, methanol may also emerge as both an operationally suitable and sustainable option, due to its potential to significantly reduce GHG emissions and typical vessel range of 450-550 nautical miles (NM). However, given methanol's low flash point and corrosiveness, double skinned tanks and leak detectors need to be installed to manage the associated safety risks. LNG and ammonia both face similar challenges. LNG requires cryogenic technology and ammonia requires specialised tank barriers. Therefore, these alternative fuels, while having a higher energy density, are more suitable to large ships that can accommodate their storage requirements.

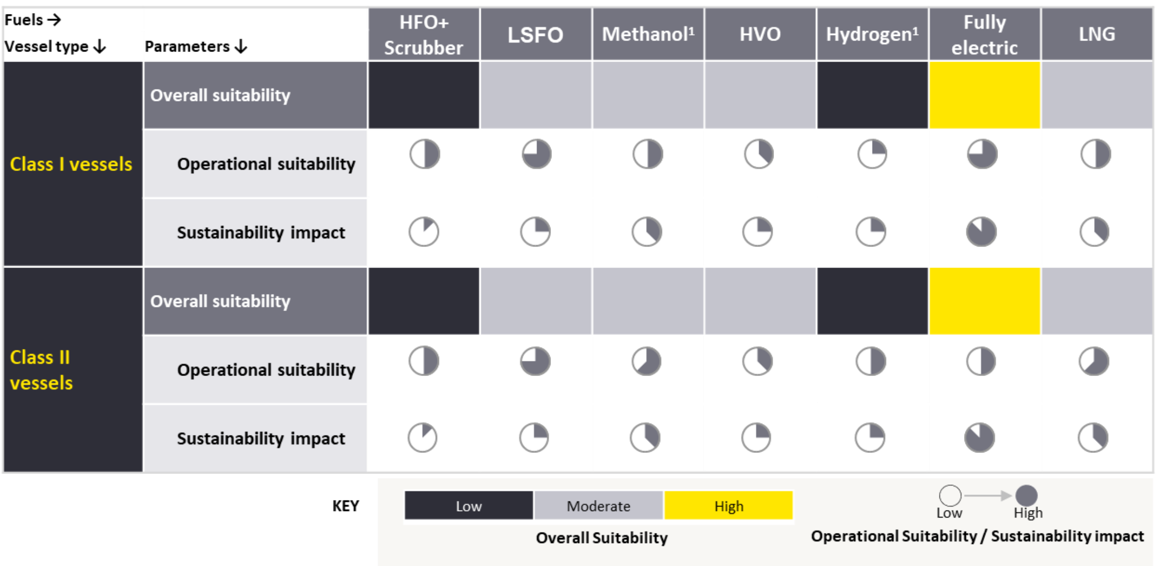
There is also expected competition for any available green methanol from the shipping industry in Hong Kong, where decarbonisation is a top priority to meet IMO's targets and avoid carbon taxation[98,99].

Methanol boasts the highest potential reduction in CO_2 with a 58% reduction per km travelled, compared with 52% for fully electric options (and 100% for the vessel owner's scope 1 emissions). Both fuels also offer significantly better air pollution profiles, with methanol offering on average 60-80% reduced NOx emissions[100].

While not part of the analysis, diesel electric and hybrid electric options have both been touted as potential transition technologies in Hong Kong. However, diesel electric vessels deliver only 3-15% emission savings[101,102], while hybrid electric achieve around 25% emission savings[103]. This is based on using hybrid in a conventional sense, not as a backup power generation to mitigate operational risks in the event of electric failure.

Considering well-to-wake emissions and local accessibility, in the short term, fully electric powertrains are identified as the most sustainable and secure option for both Class I & II vessels.

Fuel technology suitability assessment in Hong Kong (2024-2027)



Note: 1. Grey methanol and Grey Hydrogen is considered in the analysis due to its better short-term availability in global markets, including Hong Kong I 2. Ammonia is not assessed further due to its high flammability and toxicity, which pose significant safety concerns, particularly for passenger vessels. Also, significant modifications would be required to adapt existing engines on Class I and Class II vessels, making its commercial viability for these types of vessels unfeasible

98 Carbon Revenues From International Shipping : Enabling an Effective and Equitable Energy Transition
99 Climate change: Hong Kong's shipping sector 'slow to the game' with its environmental efforts, says industry body | South China Morning Post (scmp.com)
100 Is green methanol the clean fuel the world is forgetting? | World Economic Forum (weforum.org)
101 HK Star Ferry Diesel Electric Trials
102 Hybrid Propulsion Solutions Deliver 10-20% savings
103 Net-zero heroes: Hybrid and electric commercial fishing vessels set out to cut the industry's carbon emissions

Anticipated evolution of energy options by 2035

To date, the global market for eMobility has been underpinned by strong supporting policies[104], ecosystem collaboration as well as unprecedented technology advancements. Moving forward the evolution of suitable energy options in Hong Kong will be highly dependent on policies set out, the affordability and availability of alternative fuel. We look forward to 2035 to anticipate the most likely decarbonisation developments to make informed strategic choices.

[104] Electric Mobility and Development : An Engagement Paper from the World Bank and the International Association of Public Transport

In 2035, BEVs are expected to continue to be the most suitable technology as charging infrastructure is anticipated to expand to over 250,000 EV charge points in Hong Kong. BEVs are also expected to see continued improvements in vehicle range and payload capacity. The decarbonisation of the electricity mix will also further progress continuing to build the case for BEVs, with plans by utilities in Hong Kong to phase out coal fired power plants to decarbonise Hong Kong grid emissions. While Hong Kong still needs to continue to upgrade and develop infrastructure to accommodate the new wave of commercial vehicle electrification, a widespread, established and reliable electricity network already exists, which can be leveraged to accelerate decarbonisation. Additionally, EVs have been proven to be a safe technology that can operate within the densely populated city of Hong Kong with only 104 verified EV traction battery fires globally from 2010-2020[105], in comparison there were over 200 thousand car fires in the United States in 2018 alone[106].

By 2035, FCEVs are also expected to experience some advancements in fuel availability, as falling renewable power costs and improving electrolyser technologies are expected to improve the economics of green hydrogen moving forward. The cost of imported green hydrogen is projected to range between USD $3-4 per kg by 2030, according to a study by Wood Mackenzie assessing the green hydrogen delivered cost to Northeast Asia[107], with prices to end users likely to be higher.

The potential for Hydrogen is further constrained by ongoing safety and sustainability concerns. In particular, hydrogen stations will require additional considerations on siting requirements[108], including at least being 50m away from high-rise residential, education or hospital areas. In a high-density city such as Hong Kong, this may prove impractical. Additionally, the cost of establishing hydrogen refuelling stations is expected to remain significantly higher than for other energy options. And perhaps most critically, waiting for the development of hydrogen's supply chain and advancements in technology will result in delaying decarbonisation of transport; likely to result in missing Hong Kong's 2050 net zero goals.

Plug-in Hybrid Electric Vehicles (PHEVs) are anticipated to offer moderate operational improvements in the passenger vehicles and LGV sectors by 2035. However, initial trials from the Pilot Green Transport Fund in Hong Kong indicate that they are unlikely to show similar benefits in the MGVs, HGVs and bus sector; where in certain instances, Hybrid MGVs contributed 19% more carbon emissions than diesel counterparts[109]. PHEVs typically do not utilise fast charging and often depend on home and workplace charging solutions, thereby reducing the demand for public charging infrastructure. Nonetheless, challenges such as limited space in densely populated areas could complicate the deployment of these charging solutions.

[105] How common are EV fires? (evfiresafe.com)
[106] 12 Car Fire Statistics to Know in 2024 | House Grail
[107] The blue green planet: How hydrogen can transform the global energy trade | Wood Mackenzie
[108] CoP-for-HFS-issue-0_r1.pdf (cnsd.gov.hk)
[109] Pilot Green Transport Fund Trial of Hybrid Medium Goods Vehicles for Pharmaceutical Product Delivery (Pharmason Company Limited) Final Report (eeb.gov.hk)

Building on advancements in battery technology made possible by the mass adoption of EVs globally over the last decade, fully electric powertrains are expected to remain the most suitable technology for both Class I and II vessels in 2035. Coupled with global investment by governments, port authorities, OEMs and operators alike, battery electric propulsion systems, charging infrastructure and innovative battery swap systems continue to rapidly mature. Successful reference cases in the Chinese mainland also suggest rapid implementation and adoption are possible with the right support.

The cost and availability of distribution infrastructure represent a challenge for all energy options. Compared to the bunkering infrastructure and support for alternative fuels however, the cost of charging infrastructure for vessels is incurred in small increments and on a case-by-case basis as part of the capital cost of electrification of each individual vessel and is sometimes spread across multiple vessels. From a practical standpoint, this will provide the control and availability necessary to meet the individual needs of their operators and their vessels. It will also be largely built upon an existing power supply grid and may only require minimal coordination with external suppliers and technology providers, as compared with other alternative fuels. Global case studies on implementation indicate that typically subsidies are available to owners or operators to install charging infrastructure at ports.

Container batteries also serve to provide a potential alternative or supplement to charging infrastructure. In addition, container batteries also provide a possible business opportunity for market players in flexibility markets; particularly for utilities to manage charging and reduce the need to augment grid infrastructure.

LNG is expected to see significant improvements in supply availability. This will be driven by the increasing availability of LNG bunkering infrastructure and an anticipated 30% decline in LNG prices[110]. LNG is well positioned as a transition fuel for ocean-going vessels in the short to medium term. However, LNG as a cryogenic dangerous goods cargo is challenging to handle, requiring specialist training and technology, and takes up space of vessels, as such they do not lend themselves well to smaller vessels, especially when public transportation is concerned and requires widespread specialised infrastructure.

Hydrogen will also see advancements in production efficiency and increased supply of green and blue hydrogen, significantly enhancing its suitability and sustainability. However, green hydrogen economics are expected to remain a challenge, as previously mentioned. Establishing the necessary infrastructure for hydrogen availability at the port will also be challenging, as safety concerns require hydrogen storage and filling facilities to be located far from the port region, increasing fuel logistics costs. Additionally, there is no viable existing solution for transporting liquid hydrogen in bulk today at an economical cost.

Although methanol currently emerges as a potentially viable option for decarbonising Class I and II vessels, investment in green methanol bunkering facilities for harbour craft vessels in Hong Kong remains uncertain and it is expected that supply will continue to be channelled to ocean going ships from which demand is expected to increase significantly in the coming years. Furthermore, there are very limited references for existing operating vessels and options in the

LNG Dual Fuel Carrier (Source: CSSC)

[110] Global Energy Perspective 2023: Natural gas outlook

market for methanol engines for class I and II vessels, whereas electric powertrains are becoming increasingly available.

Overall, whilst there may be other potentially viable decarbonisation technologies in the long term, assuming some very real challenges can be overcome, electric powertrains emerge as the most practical and effective decarbonisation pathway for Hong Kong in the short to medium term for commercial land and marine transport.

Cost economics indicate that electrification is viable today

Total Cost of Ownership (TCO)

With the increasing ubiquity of electric vehicles and vessels globally, the transition towards green mobility is becoming less of a technological challenge for fleet owner or operators and more of a financial one. This is largely due to the higher capital cost of electric powered vehicles and vessels versus conventional ICE, despite the potential for reduced operational and maintenance costs in the long run.

To understand and illustrate the financial challenges and opportunities owner or operators are facing, EY teams undertook a high-level analysis of the TCO of electric and ICE-equivalent vehicles and vessels.

Our analysis assessed costs on 3 categories, capital expenses (CAPEX), operating expenses (OPEX) and end-of-life value across 4 vehicle segments: LGVs, MGVs, HGVs and Buses. These were then compared against an ICE vehicle baseline, where ICE is either diesel or petrol-fuelled vehicles.

Key assumptions of our analyses include:

- Typical average values expected in Hong Kong (i.e. fuel costs[111], cost of vehicle, lifecycle, etc) were used where data is available. Otherwise, global reference data was utilised to form an indicative view of TCO across these segments.
- Charging infrastructure costs are not included in the TCO analysis and are done purely from a vehicle perspective. This is because not all fleet operators will incur these costs as it depends on where the fleet drivers are expected to charge.
- The average Hong Kong vehicle travel distances were assumed for each respective segment.

The below diagram highlights which cost components of BEVs deviate from the ICE baseline and in which direction. Avoided and additional costs as well as additional proceeds as a result of choosing BEVs have also been highlighted.

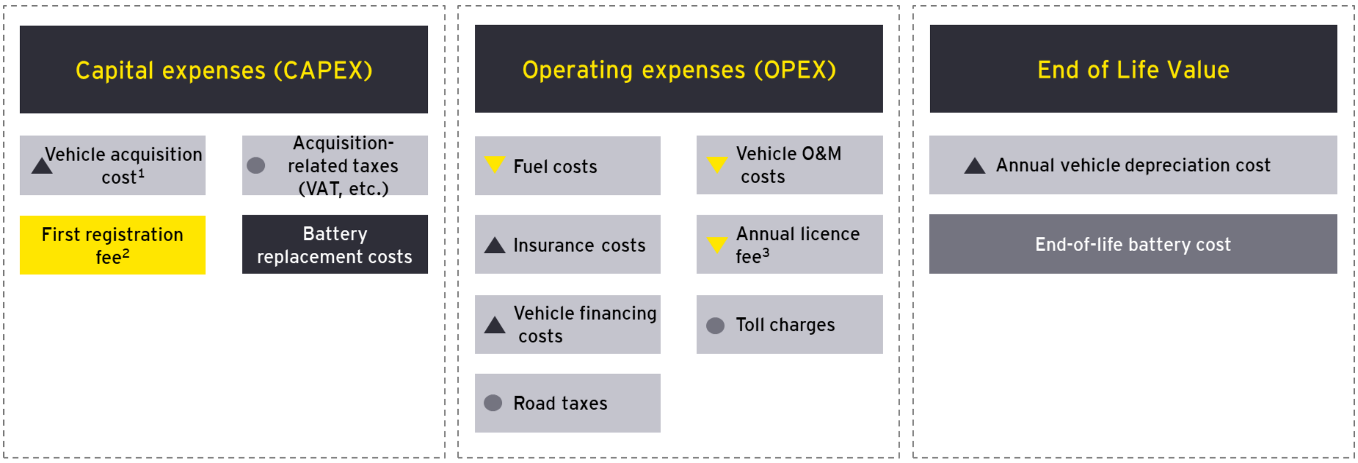
While the analysis indicates a higher capital cost of acquisition of a BEV (around two to three times the cost of a conventional ICE vehicle), a significant reduction in fuel and maintenance costs over the useful life of the vehicle (~15 years) yields a net benefit in the TCO of BEVs overall.

For both ICE and BEVs, fuel expense represents the largest cost over the vehicle lifetime. Over the past eight years, the diesel price per litre has risen over 2.5 times in Hong Kong, and the current price sitting at 240% of the world average[112], driving the business case for electrification across all commercial vehicle segments.

The result of the analysis is most compelling for LGVs, boasting an average of 43% reduction in TCO over its vehicle lifecycle, driven mostly by the difference in costs between diesel and electricity. The analyses indicates that it costs HK$53 to drive a kilometre in a diesel-based LGV, compared to HK$30 in an EV in Hong Kong.

E-buses and fully electric medium goods vehicles also offer a reduction in TCO, albeit at a lower rate at 27% and 9% respectively. HGVs on the other hand is slightly above parity at 1% above ICEs.

Land TCO Components (HK$m)



Note: 1. Does not include subsidy/ incentives I 2. The first registration fee corresponds to the vehicle registration and is 0% for electric LGVs and buses and 50% less for electric M&HCVs. I 3. Valid only for passenger vehicles and LGVs
Source: EY Analysis, Secondary research

[111] The average post discount walk-in prices of diesel of HK$19.8 was assumed for this analysis

[112] Hong Kong diesel prices | GlobalPetrolPrices.com

Fuel costs is the major driving factor and business case for EVs. For ICE buses, fuel costs contribute ~72% to the total costs, compared to only ~45% for e-buses.

Therefore, it is also worth noting that while diesel prices are expected to rise in the future, the actual prices that local fleet operators can access may vary depending on the sources of diesel they procure through different channels. Given the high upfront costs of purchasing MGVs and HGVs, operators who have access to discounted diesel prices may be hesitant to electrify their fleets.

Hence, subsidies and incentives could be considered to help reduce the upfront vehicle costs and associated charging infrastructure expenses to encourage the transition to electric commercial vehicles.

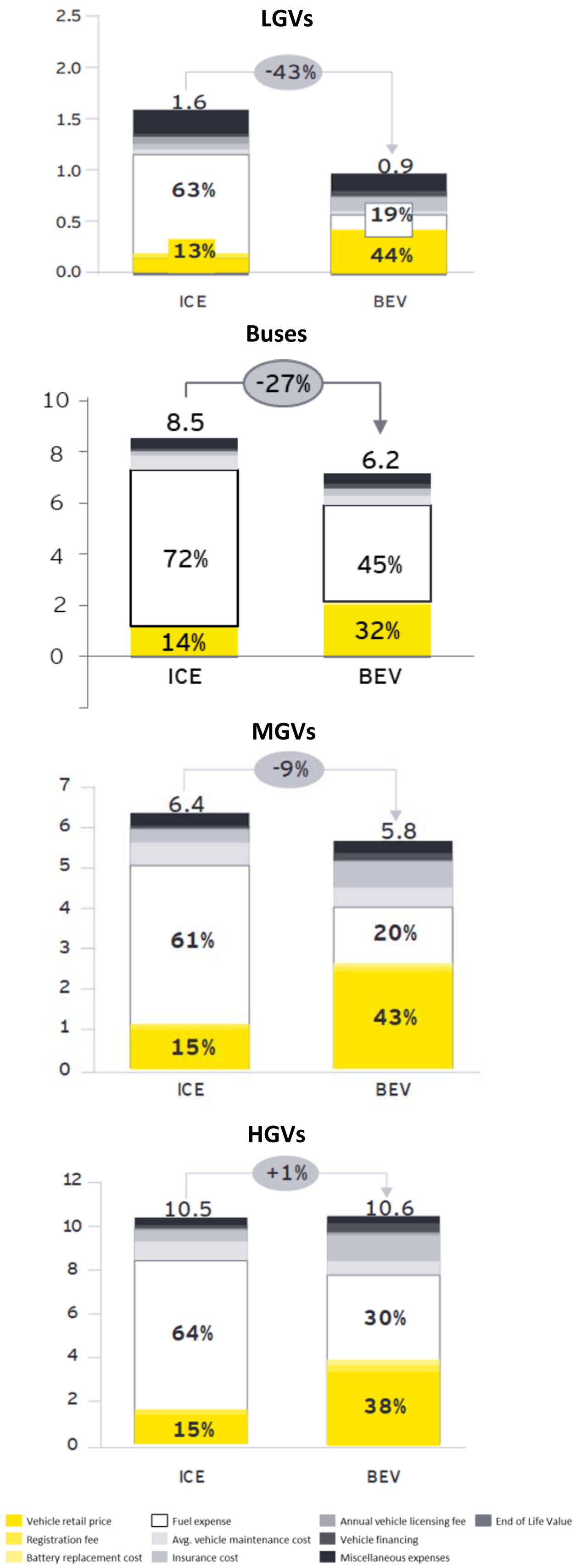
Throughout this study, industry stakeholders also raised feedback and concerns on some key factors influencing TCO. As such, a sensitivity analysis was conducted to assess how the below sensitivity levers affect the TCO:

- Removal of existing government first registration tax incentives
- Providing subsidies for 50% vehicle purchasing costs
- Discounting diesel price from current HK$20
- Reduced EV fuel efficiency by 20%

The results indicated although TCO outcome sounds encouraging, subsidies and fuel prices are critical factors influencing TCO and setting pace for electrification of transport.

Despite encouraging TCO results, subsidies and fuel price are critical factors influencing TCO and setting pace for electrification of transport.

Share of cost components in TCO by Powertrain ($HK millions)



Similarly, the TCO analysis for the maritime sector also assessed CAPEX, OPEX and End of Life value across two segments, class I & II vessels, and compared them against an ICE baseline, where ICE were assumed to be marine diesel.

The maritime sector is facing challenges similar to those experienced by commercial vehicle operations. Namely, the significantly higher capital cost of electric vessels. The difference is less pronounced for vessels than for vehicles though, mostly due to an already high baseline cost of acquisition and a design or construction process that necessarily accommodates high levels of customisation to meet specific operational needs. This design or construction process means that a level of complexity is already factored into the baseline price and the specification of a battery electric powertrain does not dictate an increase in cost on the same relative magnitude seen when comparing BEVs to ICE vehicles.

Across all vessels analysed, a useful life of 30 years was used and battery replacement costs at 10-year intervals were also accounted for. While this is a slight deviation from industry practices relating to the expected useful life of vessels, it allows for full the full lifetime utilisation of each replacement battery which is in line with how commercial operators will likely adapt.

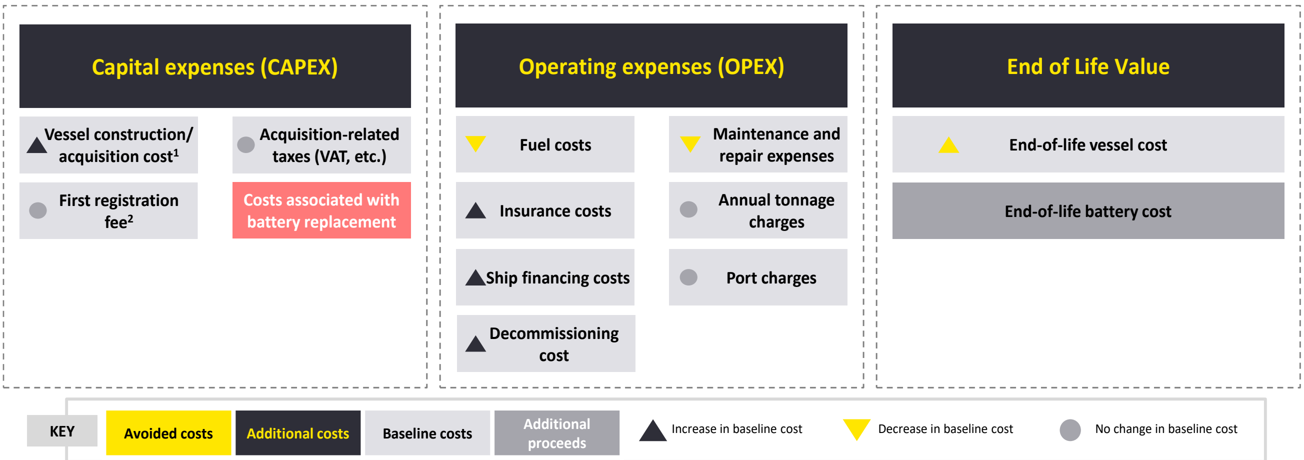
The TCO analysis for marine vessels does not include the costs of charging infrastructure. This is because the charging infrastructure costs can vary greatly depending on the situation, such as when chargers can be shared between multiple fleets or operators.

Some operators are considering diesel-electric vessels as an alternative option. While the upfront price of these diesel-electric ferries may be lower than pure electric vessels, they still rely on diesel fuel to power an electric drive train, which does not represent a genuine solution for decarbonisation and is therefore not included in TCO analysis.

The analyses shows that Electric Class I vessels in Hong Kong have lower TCO compared to diesel-powered vessels, driven by the fuel price difference between marine fuel and electricity, with the overall TCO for an electric ferry being 2% lower compared to their diesel counterparts, even though the construction/ acquisition costs are 42% more expensive compared to a diesel-powered ferry. Maintenance and repair costs contribute only 21% to the total costs of an electric ferry, compared to 29% for conventional ferries.

Electrification of launches demonstrate a ~21% reduction in TCO, driven by higher battery efficiency and hence lower electricity costs. For diesel-powered launches, fuel costs account for HK$43m of the total lifecycle costs (for a 30-year lifespan), nearly 2.7x that of e-launches.

Maritime TCO Components (HK$m)



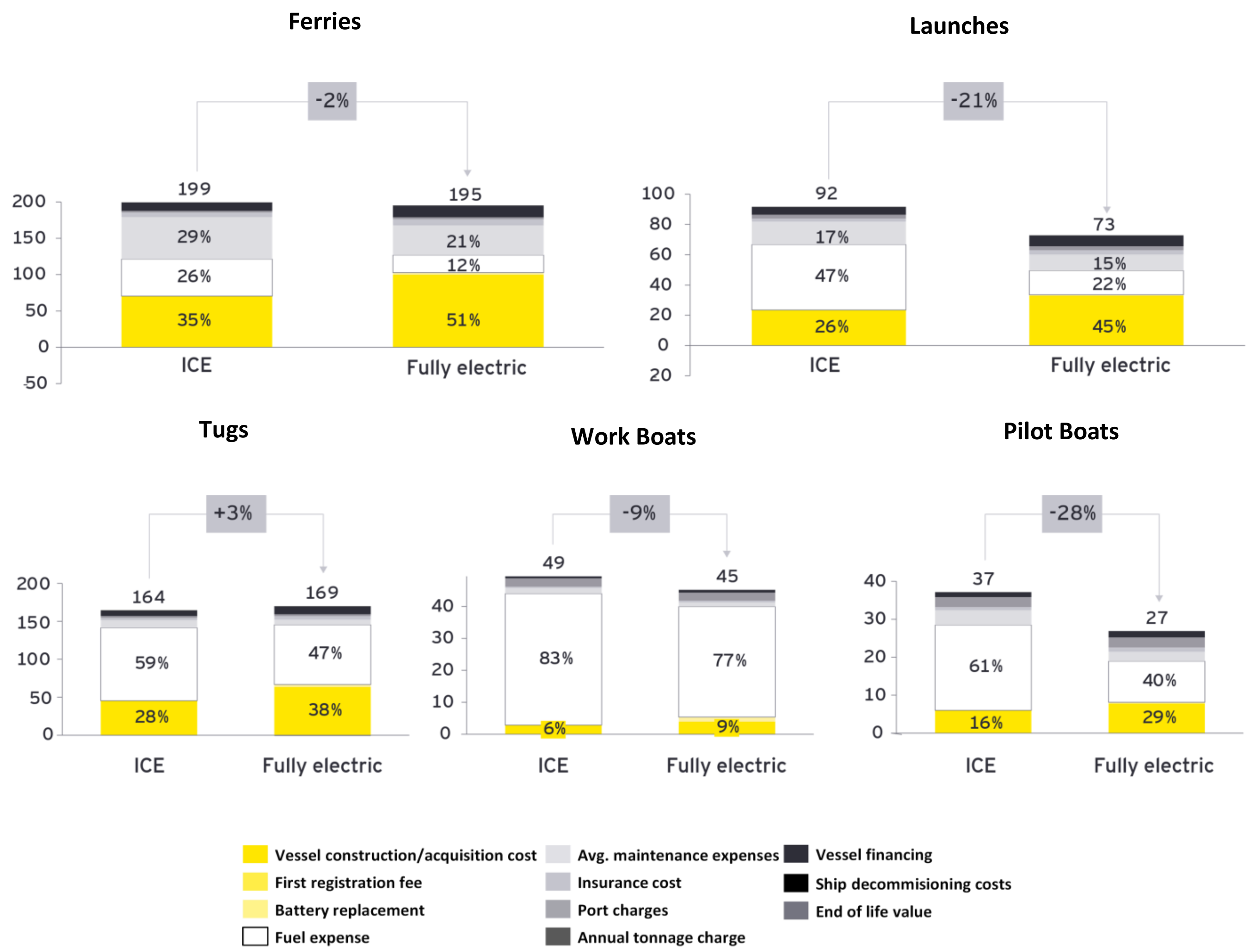
For class II vessels, work boats and pilot boats demonstrate a 9% and 28% lower TCO respectively compared to their diesel counterparts. The reduction is primarily attributed to the substantial difference between the prices of marine fuel and electricity as well as higher energy efficiency, where continuous growth arising from advancement of technology is being observed (such as use of e-hydrofoiler technology in pilot boats).

The magnitude of reduction for work boats is due to the varying nature of which these vessels are deployed. Operation profiles may be for transportation or coastal construction, hence savings may vary and EY teams estimate savings up to ~25% based on sensitivity checks on this analysis.

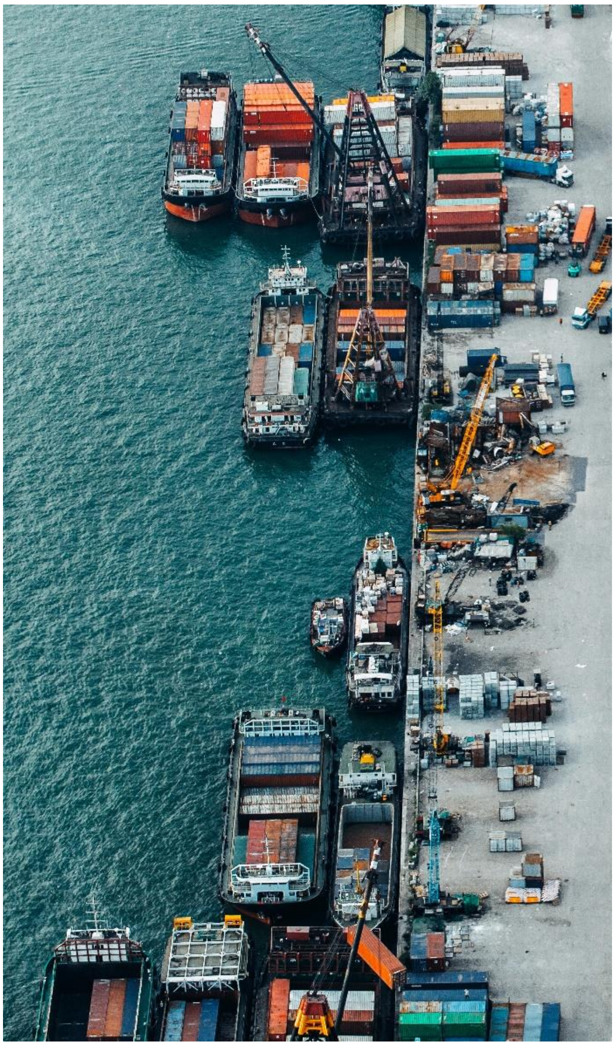
Fully electric tugs, on the other hand, demonstrate a marginally higher 3% TCO compared to its ICE counterparts. This TCO disadvantage is driven by the requirement for a larger battery size to accommodate power-intensive operations, resulting in higher CAPEX.

However, electric tugs operate at 13% less OPEX, compared to the diesel-powered tugs, driven by lower fuel and maintenance costs, with maintenance costs for electric vessels being on average 50% lower than compared with diesel engine vessels[113,114]. Furthermore, during the course of this study, engagement with industry cited the lack of qualified mechanical engineers in Hong Kong as a growing concern and one of the benefits of switching to lower maintenance electrical propulsion[115].

Share of cost components in TCO by Powertrain (HK$m)



Whilst the TCO indicates that the margin between conventional ICE and electric ferries is narrow in most cases, the analysis still suggests there is a net positive benefit in electrification over the useful life of the asset. This benefit increases for smaller vessels, which are less costly and complex to design and construct. In these cases, fuel costs are a larger contributor to the TCO of the vessel compared with more expensive and complex vessels such as ferries and tugs (see page above).



However, the deployment of the necessary charging infrastructure can represent a significant upfront cost consideration for some operators, separate from the vessel construction or acquisition costs. Therefore, targeted incentives to support these upfront charging infrastructure costs should be considered to help facilitate the transition to electric marine vessels.

The sensitivity analysis on Maritime TCO suggests that financial subsidies are crucial for improving the economic viability of electric vessels, while some adjustments in financial structuring (like the debt-equity ratio) can also positively influence the TCO. Fuel efficiency at the specified rate appears to be a stable factor with no significant deviation from the base case.

The well planned deployment of suitable charging infrastructure is vital

Current state and incentive to act

The availability of suitable charging infrastructure stands out as a major determining factor in the rate of electrification of the transport sector across both land and marine contexts globally.

Mainland China is the current global leader in the number of publicly available chargers[116], accounting for 83% and 56% of the world's fast and slow chargers respectively. While this is encouraging for consumers, the needs of commercial fleet operators are more nuanced and a focus solely on public charging in Hong Kong will likely not be sufficient to support the transition of commercial fleet operators.

In Singapore, the MPA plans to progressively rollout shared-use charging infrastructure for use by electric harbour craft with a new charging port and mobile charging concept being piloted in Marina South starting in 2024[117]. A significant step to achieve Singapore's ambition of decarbonising all harbour craft operations by 2030.

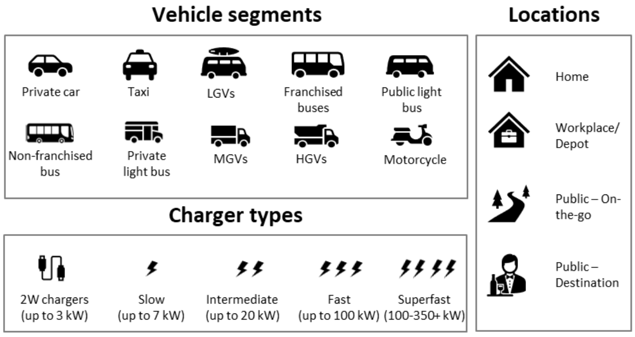
To fulfil Hong Kong's green transport ambition and meet 2050 decarbonisation targets, the well-planned support and deployment of robust charging infrastructure will be vital. To understand the scope of this challenge and the unique needs of both land and marine transport operators, EY teams undertook high-level EV demand modelling and analysis of charging needs across different vehicle and vessel segments.

[116] Outlook for electric vehicle charging infrastructure – Global EV Outlook 2024 – Analysis - IEA

[117] Singapore begins pilot of electric harbour craft charging point in Marina South (businesstimes.com.sg)

EV uptake and resulting charging infrastructure needs analysis

The diagrams below show the vehicle segments, charger types, and charger locations considered in the high-level EV demand and charging infrastructure analysis. Charging infrastructure needs were evaluated segment-by-segment using up to date market data to forecast uptake up to 2050, and estimates were based on three major factors: EV Parc, Annual Mileage and EV Efficiency.



Road transport in Hong Kong presents an immense opportunity for decarbonisation and the reduction of air pollution with electrification potential as high as 93-99% across all the segments by 2050. EY high level analysis on initial uptake estimates are constructed around three scenarios:

- 'Slow' case assumes the eMobility market development remains somewhat fragmented, lacking a coordinated approach and barriers are not tackled resulting in a slower electrification rate and decarbonisation targets not met.

'Moderate' case assumes as-is progressive policy measures (e.g., ICE-private cars banned by 2035) are put in place and current market EV trials are progressively scaled up with corporate investment.

- 'High' case assumes earlier achievement of government targets by taking advantage of a proactive whole of market coordinated approach in planning the design of the ecosystem and further government investment to accelerate electrification beyond private vehicles – e.g., buses taxis, and commercial fleets.

The charging infrastructure analysis was developed utilising the moderate EV uptake scenario. It indicates that approximately 560k chargers will be needed to service an estimated 1.1M EVs by 2050. The following charts show the specific charger requirements by location and type which highlights several important planning considerations.

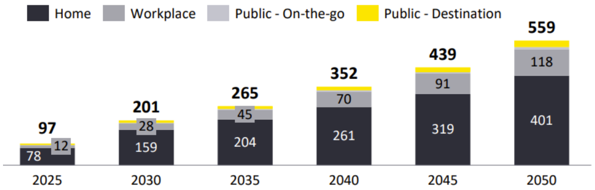
Slow chargers servicing private vehicles and LGVs are expected to constitute 78% of all chargers by 2050, while approximately ~35K fast and super-fast chargers are also expected to be required, primarily to meet the needs of commercial vehicles due to their higher annual mileage, larger battery and

Locations	Elaboration
Home	Deployed in both multi-dwelling units (public and private housing) and single housing units. These chargers are restricted to only private charging. 2.5-7kW slow chargers are most commonly used.
Workplace	Chargers deployed in: • Corporate office buildings • Industrial parking, depots (incl. loading & unloading bays), logistics hubs • Government offices, Bus transit station/bays, schools, taxi-stands, Public Transport Interchanges etc. For charging of both employee-owned and company-owned vehicles, fleet and public transport operators. The chargers mostly cater for private charging of commercial vehicles.7-100kW chargers are most commonly used.
Public – Destination	Chargers co-located at car parks and pre-existing retail facilities e.g. shopping malls, city centres, hospitals, amusement parks, restaurants etc. where you park and charge for convenience while engaged in other activities such as shopping or dining. Commercial vehicles stand to benefit from chargers situated in loading and unloading bays of these destinations. 7-60kW chargers are most commonly used.
Public – on-the-go	Chargers located at petrol/charging stations and on-street public parking. It also includes the standalone kerbside and light pole chargers. These chargers are completely open for general public and also help to facilitate top-up charging for commercial vehicles en-route to and from their destinations. 22-200kW chargers are most commonly used, with up to 350kW for super-fast chargers.

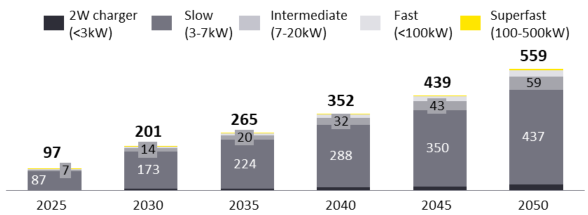
shorter dwell times. A closer look at Hong Kong's charging segment mix also reveals the current and planned charging installations are much higher at 'Home' and 'Workplace', catering to the needs of private car owners. Hence, commercial fleet operators are cautious on BEV's operationally suitability and will require developments that support their needs.

With Hong Kong's real estate constraints, it will be critical to effectively utilise the existing 690k parking spaces available in Hong Kong, of which 495k are designated for private use. This includes the right mix of incentives and policy to drive private market players to install charging fit for commercial vehicle usage and are available for public use where possible. Global experience suggests, there is a higher penetration of fast charging in dense urban areas, which offer potential synergies in HK with adoption of electric commercial vehicles. On the back of EY team's analysis, several key observations were made across each charging location segment, which prompts future planning considerations when designing an effective ecosystem that encourages EV uptake across all vehicle segments.

Charger requirement by charging location (000s)



Charger requirement by charger type (000s)



Charging locations	Key observations	Future planning considerations
Home	▸ By 2027/28, home charger demand is expected to rise to 110-130K, in line with the government's target of 140,000.	▸ It is worth noting that the majority of the population resides in high-rise apartment buildings, signifying less access to home charging. To meet the charging demand for the entire ecosystem, other segments such as Public charging and Workplace (e.g., at commercial buildings)[118] will have to compensate and absorb this demand.
Workplace	▸ Across workplace and public destination sites, 28,000 chargers are needed by 2030, nearly double the current number available as of February 2024 (~16K).	▸ Depot charging and public transport interchanges (PTIs) will likely be necessary to encourage and enable the electrification of commercial fleets, buses, and taxis. ▸ Examples for strategic locations include: ▸ Industrial estates such as Tai Po, Fo Tan, Kwun Tong, Yuen Long and similar commercial, industrial and logistics hubs
Public - Destination	▸ Approximately 10,000 public destination chargers will be required by 2030. ▸ By 2050, destination charging will make up around 5% of total chargers with ~30,000 chargers.	▸ Examples for strategic locations include: ▸ Car parks with existing commercial vehicle parking ▸ Loading and unloading bays in key commercial areas, shopping malls and logistics centres
Public - On-the-Go	▸ Demand for public on-the-go charging is expected to increase to 2,500 by 2030, and 10,000 by 2050.	▸ Urgent planning focus will be needed on 'Public on-the-go' fast (60-200kW) infrastructure. ▸ Examples for strategic locations include: ▸ Major on-route destinations like the Kwai Tsing container terminals and the Hong Kong International Airport ▸ Petrol filling stations into quick charging stations ▸ Other under-utilised public spaces near high commercial traffic zones, such as areas under major flyovers across Hong Kong

[118] EV_charging_guide_03162020.pdf (theicct.org)

E-vessel uptake and resulting charging infrastructure needs

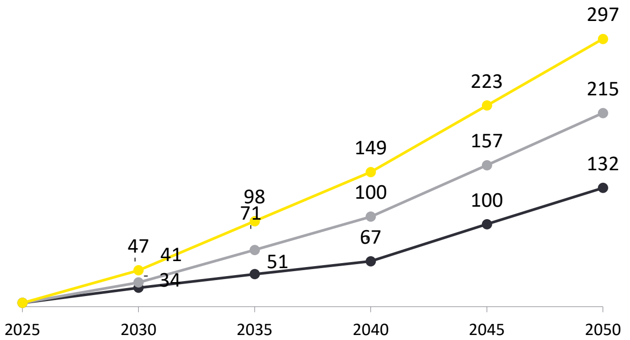
With limited market data available on which to base an accurate projection of the likely rate of electrification across different vessel segments in Hong Kong between now and 2050, EY teams analysis looked at each of the sub-segments of Class I and II vessels and considered characteristics such as age, construction, operational profile and potential for electrification based on current technologies (and their expected evolution in the coming years) to forecast three separate uptake scenarios. These are explained below followed by e-vessel uptake graphs[119].

- **Low scenario:** This scenario envisions limited adoption of electric vessels in Hong Kong lacking a coordinated approach and barriers are not tackled resulting in a slower electrification rate and decarbonisation targets not met.
- **Moderate scenario:** Moderate adoption is anticipated, supported by a progressive policy measures and current market EV trials are progressively scaled up. Technological advancements improve the viability of electric propulsion, particularly for passenger ferries and short-haul cargo vessels. However, conventional vessels or other alternate fuel technologies still dominate the power-intensive and large-scale operations.
- **High scenario:** In this scenario, strong policy mandates and incentives for zero-emission vessels as well as a proactive coordinated ecosystem approach for electric-powered vessels drive ambitious electrification efforts across Hong Kong's maritime vessels. Vessel operators are transitioning rapidly, with electric vessels becoming the preferred choice across most vessel types and routes, driven by significant advancements in battery technology and lower electricity prices.

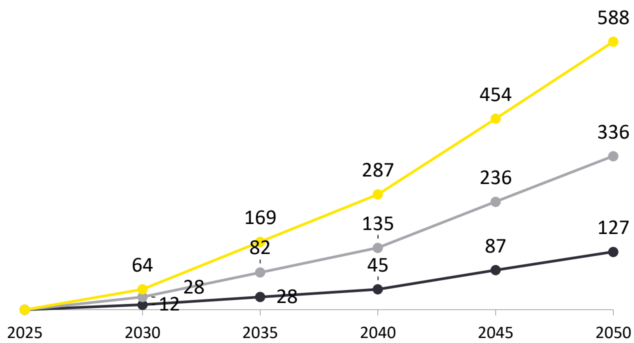
Active pursuit of the "Moderate" or "High" scenario in Hong Kong (with timely policy measures and a proactive coordinated approach) is expected to realise earlier electrification adoption and maximise decarbonisation benefits. It would result in electrification potential between 65% to 90% for Class I and 40% to 70% for Class II vessels by 2050.

While a margin of error can be assumed in the resulting values, they still serve as a useful guide and for planning purposes, likely represent a conservative estimate. It should be noted however, that any uptake beyond the four ferries that have been subsidised to date[120], is likely be contingent on clear signals to the market.

E-vessel parc – Class I vessels (#), by scenario



E-vessel parc – Class II vessels (#), by scenario



Low adoption · Moderate adoption · High adoption

*Notes: *For passenger vessels only. The e-vessel uptake for launches is assumed to be 0% in 2025 I The total number of vessels in Hong Kong is assumed to be constant during the forecast period (2024-50) .Total number of vessels considered in the analysis under Class I and Class II are 329 (84% of total Class I vessels in 2023) and 836 (46% of total Class II vessels in 2023), respectively, based on their potential for electrification.*

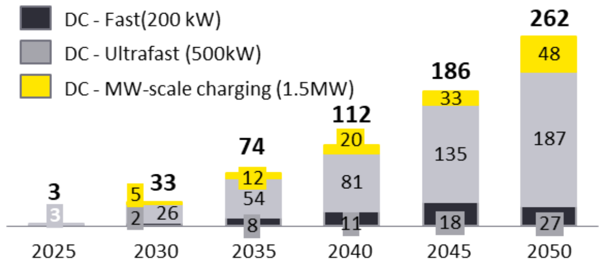
Source: HKMD, EY Analysis

[119] E-vessel parc refers to the number of vessels
[120] EPD and ferry operators sign Pilot Scheme for Electric Ferries subsidy agreement (with photo) (info.gov.hk)

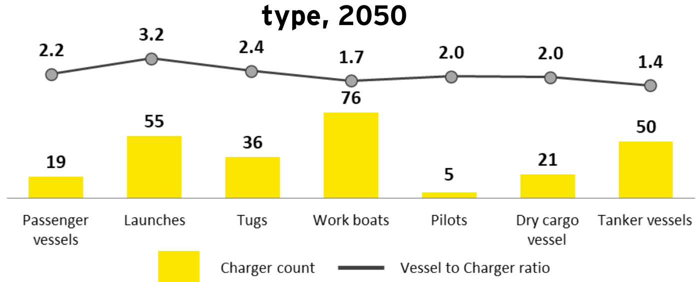
Infrastructure needs

In the "Moderate" uptake scenario, approximately 33 chargers will be required to meet the charging demands of 69 Class I & II e-vessels by 2030. By 2050, this figure may increase to 250+ chargers to support the charging needs of 550+ Class I and II e-vessels.

Charger requirement by charger type



Charger distribution by vessel and charger type, 2050



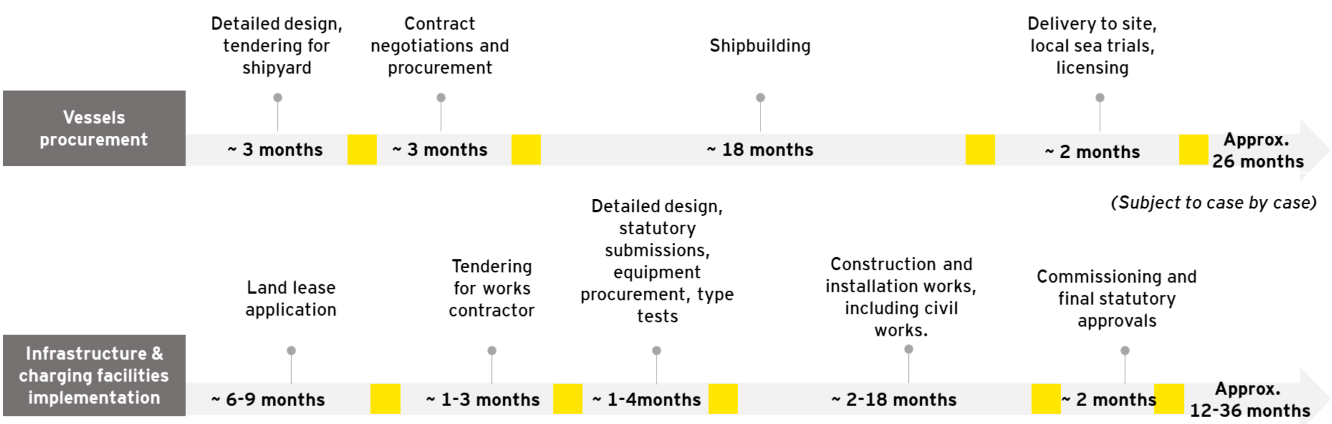
In planning and developing the required infrastructure, the solution is unlikely to be straightforward as simply providing 250+ chargers in line with this analysis. First, as shown in the figure below, the prolonged lead time of vessel procurement and infrastructure development is required.

Also, significant diversity in vessel types, use cases, and operational profiles within classes and sub-segments means stakeholders will need to be collectively consulted and infrastructure development undertaken with a high level of coordination to make best use of the limited space available for the installation of chargers. On the positive side, battery swap technology offers a pathway to reducing the number of chargers required at berths by enabling off-site charging - there are several global examples of this being successfully implemented and the technology and number of market players offering such services is rapidly advancing.

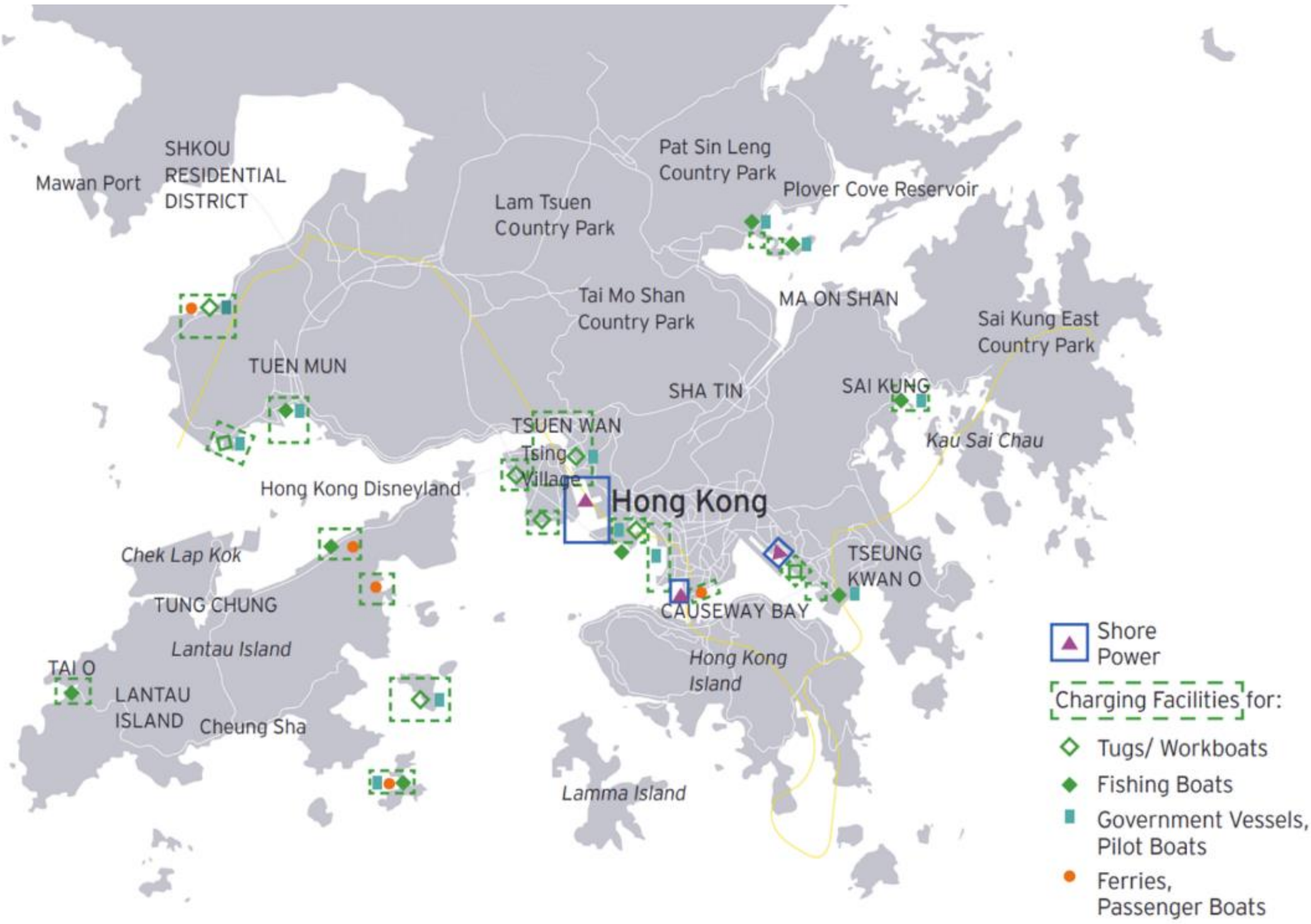
All in all, initially, installation of chargers in strategic locations that offer mutual convenience for the most operators will be essential to promoting and supporting fleet electrification. Through consultation with industry stakeholders, several potential locations have been indicated for the following reasons:

- Operating profiles including geography of users;
- 24/7 availability to suit operating needs;
- Sufficient water depth (>7m) at proposed berthing locations is required to accommodate berthing of tugs due to their relatively deep draft;
- Sufficient land space to accommodate charging facilities, as well as power infrastructure e.g. distribution substation.

Indicative timeline for vessel procurement and infrastructure development ***(varies case by case)***



In most cases these charging locations could serve multiple types of vessels (see the map below) including tugs/workboats, government vessels, pilot boats, ferries and fishing boats. With expected collective benefits (both environmental and economic) among maritime industry operators the strategic charging locations present opportunity to be the most efficient solution to accelerating electrification of harbour fleet in Hong Kong in the near term. Infrastructure, however, is costly and similar to land electrification learnings, will require government support and market's upfront investment to overcoming a chicken-egg dilemma – with charging coming first and followed by e-vessel uptake.



Note: The analysis of these locations were constructed based on feedback from stakeholder interviews covering Kowloon, New Territories and Outlying Islands only and will need to be supplemented with HK Island locations.

While the charging requirements for land transport, harbour fleet and OPS are distinct, there are potential synergies to be realised by developing shared infrastructure across segments to meet the needs of multiple transport modes and optimise investment which is crucial for efficient transition to eMobility.

Onshore Power Supply (OPS)

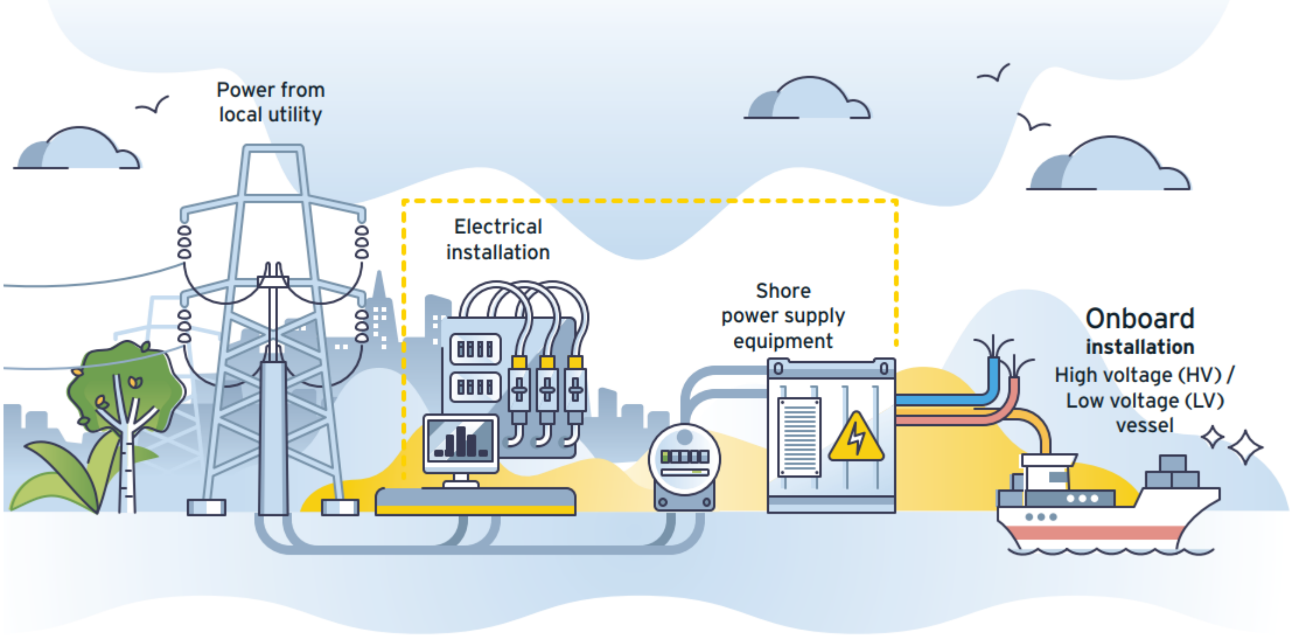
While the charging requirements for land transport, harbour fleet and OPS are distinct, there are potential synergies to be realised by developing shared infrastructure across segments to meet the needs of multiple transport modes and optimise investment which is crucial for efficient transition to eMobility.

For completeness it is also vital to emphasise the infrastructure requirements associated with the provision of OPS to ocean-going vessels calling at Hong Kong Ports. As shipping and cruise companies continue to retrofit vessels to accept shore power and with the order book of new build ships reflecting a strong trend towards shore power compatibility in response to IMO targets and new emissions penalties[121], it is important for Hong Kong to maintain pace with other global ports. The potential economic impact of this cannot be understated, where the absence of OPS may result in shipping companies opting to call at regional ports instead of Hong Kong Ports in order to meet their sustainability targets and avoid carbon taxes. Both the Chinese mainland and EU's ports already have widespread implementation of OPS, with more than 400 berths across 21 coastal ports in the Chinese mainland[122] providing OPS and majority of European ports aiming to offer OPS facilities to vessels by 2030[123].

Infrastructure needs of Onshore Power Supply

Port and terminal operators in Hong Kong have suggested that, at present, the capital cost of installing OPS and the ongoing operational cost does not make for a viable business case, despite growing enquiries from shipping companies. From a broader economical perspective however, and certainly from a sustainability point of view, the development of OPS for use by ocean going vessels represents a significant opportunity for Hong Kong. According to EY teams estimates, approximately 200 kilo tonnes of carbon may be saved annually by 2050. This is based on the annual arrival numbers of cruise ships and container ships for 2023, projected to remain constant through 2025 under a moderate scenario, assuming that OPS is available and fully utilized by vessels calling at Hong Kong Port. The infrastructure, however, is costly, and space in Hong Kong is limited. Terminal operators are unlikely to invest without government support and even then, they will inherit responsibility for the ongoing operation and maintenance of the OPS.

Shore power infrastructure



[121] EU rules drive marine demand for shoreside power; infrastructure needed | S&P Global Commodity Insights (spglobal.com)
[122] China leads world in utilizing shore power | govt.chinadaily.com.cn
[123] EU AFIR: Ports must provide shore-side electricity by 2030 - SAFETY4SEA

Carbon emission impact estimate

In order to understand the scale of potential impact of electrification in the context of Hong Kong's decarbonisation journey, EY teams conducted a high-level carbon emissions impact estimate.

The estimation was conducted by taking the EV and Vessel uptake as well as shore power and corresponding potential annual electricity demand to assess the resulting decrease in annual diesel consumption, increasing electricity generation related emissions and the resulting avoided carbon emissions.

The key assumptions for this analysis includes:

- The annual electricity demand for each segment is based on existing operational and power requirements
- The corresponding fuel efficiency is between 0.4-0.52 of fuel for every kWh
- One litre diesel of diesel is assumed to generate 2-4kg of CO_2
- The projected grid emissions factor of 0.1kgCO_2/kWh and 0kgCO2/kWh in 2035 and 2050 were used respectively[124].

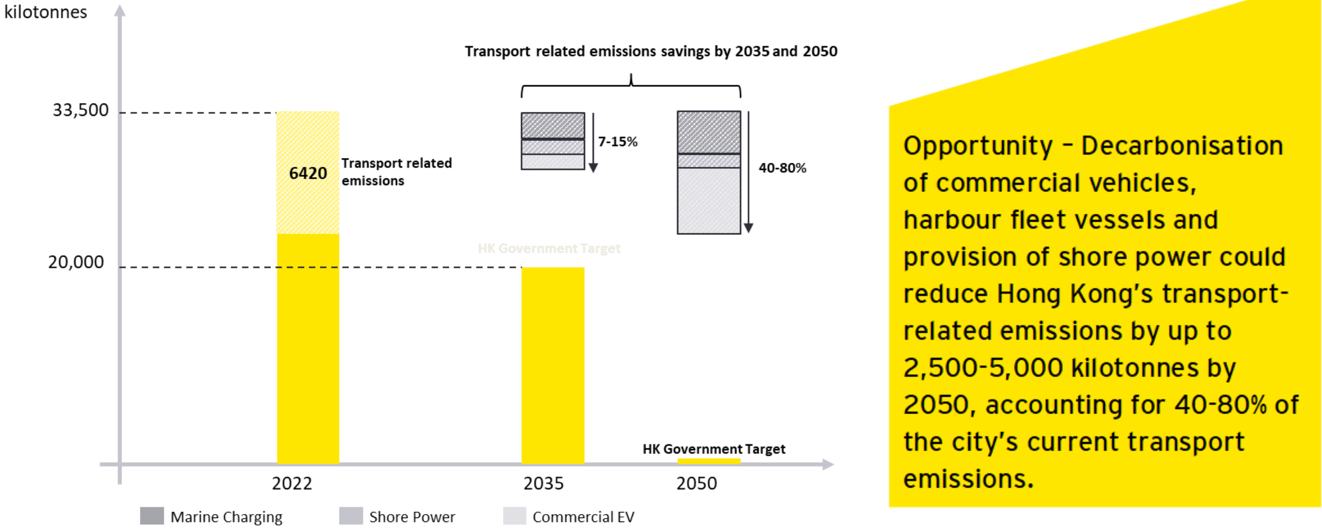
The figure below shows that under a moderate adoption scenario, the promotion of electrification across land and maritime sectors as well as use of shore power can reduce potential emissions by up to 500-1,000 kilotonnes of CO2 by 2035 and 2,500-5,000 kilotonnes by 2050, saving around 7-15% and 40-79% transport related emissions by 2035 and 2050 respectively (compared with a 2022 transport emissions baseline[125]).

In addition, Hong Kong utilities have taken substantial steps to date to decarbonise its grid. Today, Hong Kong has achieved a 33% reduction when compared with the peak of about 31.2 million tonnes in 2014. By 2035, Hong Kong utilities have committed to phase out coal-fired plants and supplement generation through cleaner energy sources such as nuclear and renewables, targeting 60-70% of zero-carbon energy before 2035[126] and is expected to achieve a CO_2 emissions factor of 0.1kgCO_2/kWh.

Apart from CO_2 benefits, the Hong Kong Clean Air Network conducted an air pollution test at the Kai Tak cruise terminal, revealing that the presence of a docked cruise ship resulted in an approximately threefold increase in nitrogen dioxide (NO_2) concentrations in the surrounding air and exceeded the World Health Organisation (WHO) standards by almost 9 times, endangering public health[127].

Hence, electrification has immense potential in delivering tangible results and its benefits should not be underestimated. In the following section, EY teams explore the challenges faced by Hong Kong's industry stakeholders today and the potential recommendations to overcome these barriers in order to accelerate the onset of electrification across land and maritime transport sectors.

Carbon emissions impact estimates



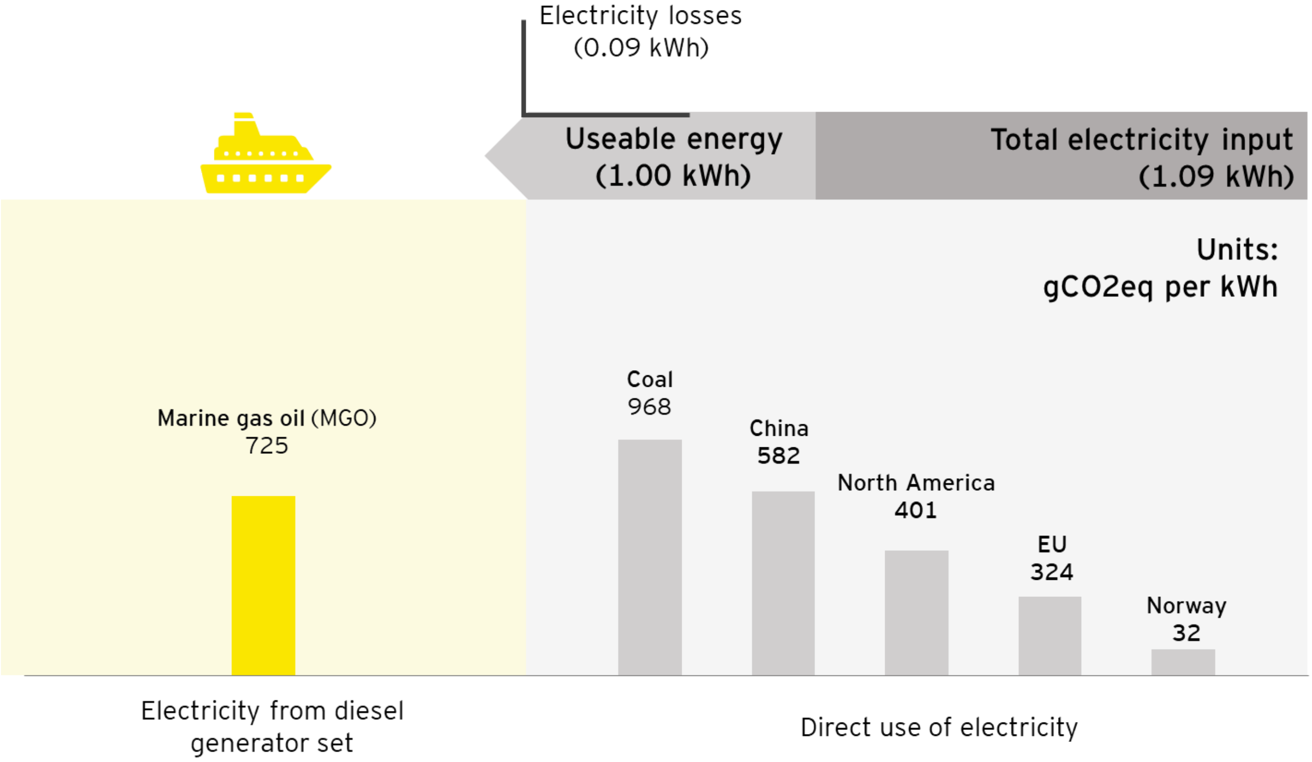
[124] HK-transport_Final_20220930.pdf (civic-exchange.org)
[125] CNSD Greenhouse Gas Emissions in Hong Kong (by Sector) 2022
[126] Hong Kong's Climate Action Plan 2050 (cnsd.gov.hk)
[127] Cruise ship emissions cause hazardous NO2 levels - Clean Air Network

A study conducted by DNV highlights the direct use of electricity from shore is the most efficient way to power ships while at berth and the overarching environmental benefits of utilising shore power over onboard marine gas oil (MGO) fuelled generators. The research reveals that electricity sourced from the grid can lead to significant reductions in CO_2 emissions per unit of energy compared to electricity generated by MGO-powered diesel generators[128].

The emissions factor associated with MGO-fuelled generators is estimated to be 725 grams of CO_2 equivalent per unit of energy, which is substantially higher than the emissions factors for grid electricity in various regions. For example, the European Union (EU) has an emissions factor of 324, while North America and China have emissions factors of 401 and 582, respectively.

These findings underscore the potential for shore power to contribute to more effective emissions reductions compared to relying on onboard fossil fuel-based power generation. By leveraging grid electricity, ships can significantly reduce their carbon footprint and minimise their environmental impact when berthed at ports equipped with shore power facilities.

Energy use and emissions associated with direct use of electricity v.s. electricity from onboard diesel generator set fuelled by marine gas oil



[128] Maritime Forecast to 2050 by DNV

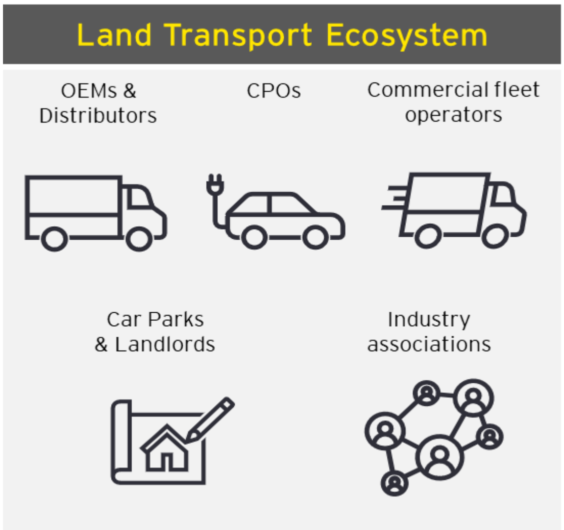
3. Challenges and pragmatic recommendations

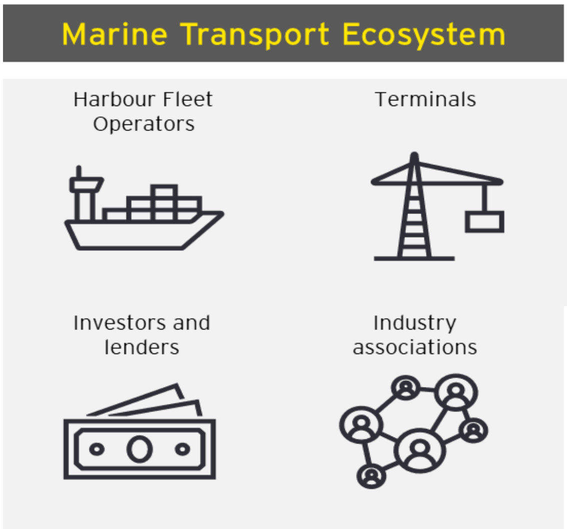
The transition to electric powertrains represents the most practical and effective pathway for decarbonising commercial land and marine transport in Hong Kong over the short to medium term. However, despite cost and emissions benefits, fleet owners and operators in Hong Kong have been slow to embrace electrification. While there is little doubt that the transition to green transport represents a complex and costly undertaking, it remains an essential one for Hong Kong to achieve its 2050 net zero goals, improve the quality of life of its citizens and tap into the economic potential of the green economy.

Throughout the study that led to this report, EY teams engaged with over 30 local stakeholders across land and marine transport to gain insights into the real-world challenges in decarbonising commercial operations and to collectively define some potential solutions. The stakeholders were carefully selected to ensure the full breadth of market players and ecosystem participants in Hong Kong were represented. This enabled the collation of insights and perspectives required to develop holistic and pragmatic recommendations in response to the challenges different stakeholders revealed, with consideration for Hong Kong's unique context.

Throughout the interviews, which were supplemented by benchmark studies and research into global case studies and best practice examples, a range of barriers to electrification in Hong Kong were identified. These can be grouped under the five key themes described below.

Below is the summary of the challenges and recommendations for Land and Marine, with further detail provided in subsequent pages:





Key barriers	Factors to be considered
Policy and regulation	Targets, incentives, and other policy measures to support the transition to electrified transportation.
Operational Feasibility	Availability of electric vehicles and vessels that meet business requirements in terms of range, speed, and payload capacity.
Charging infrastructure	Public charging networks, power transmission, coupled with the need for standardised guidelines for infrastructure development.
Economic consideration	Upfront investment costs for electrification, access to capital, and funding options for transportation electrification projects.
Other challenges	Local market capacity, availability of skilled labour for maintenance and operation, battery life and recycling options.

Key challenges	Recommendations
Policy and regulation	
No roadmap and targets for commercial vehicles yet resulting in "wait and see" approach *"We would like more clarity on the roadmap and incentives before fully committing to the electrification process." - commercial fleet operator*	L1 & L2: Clear and holistic targets for the near and medium term are critical to prompt action. Roadmap with phased approach targeting LGVs and MGVs for decarbonising commercial vehicle fleets need to be defined and communicated transparently. An EV taskforce, consisting of inter-departmental government and key industry stakeholders is critical to coordinate and accelerate planning, permitting and implementation across complex stakeholder landscape. Global case: Mainland China has ambitious targets for EVs including commercial vehicles, set for the near, medium and long term at both national and provincial levels to achieve carbon neutrality by 2060. It also aims to establish a comprehensive charging network that spans urban, highway and rural areas.
Outdated regulations and standards resulting in barriers to EV uptake *"The weight of the battery pack in an electric truck has a significant impact on the actual payload capacity, meaning we may need to licence the vehicle under a higher class." - commercial fleet operator.*	L3: The current legislative and regulatory policy and process could be revisited and optimised to better accommodate the transition to EVs, particularly to accommodate the payload capacity due to heavier battery packs. Other areas require attention include licensing and permitting processes for infrastructure development. Global case: The EU plans to remove barriers and provide incentives for adopting zero-emission technologies and energy-saving devices in the HDV sector. One proposed policy allows zero-emission HDVs to have extra weight and length, compensating for heavier powertrains and providing additional loading capacity.
Operational feasibility	
Limited availability of suitable commercial EV models in Hong Kong *"There is a lack of available EV trucks that suit our operational needs, especially for medium and heavy goods trucks. There are only a few models in the market right now, and they are still very expensive." - commercial fleet operator.*	L4 & L5: The type-approval process and evaluation framework in Hong Kong could be streamlined to reduce time-to-market for EV OEMs, while maintaining best-in-class safety standards for citizens. Industry bodies, R&D centres, the government, the industry could consider collaborating with vehicle manufacturers to fast-track approval of commercial model EVs that are suitable for the Hong Kong market. Consideration of a mechanism for rapid approval of models that have already been approved for GBA is another potential action. Global case: To tackle the challenge of limited electric commercial vehicle options, large corporations and fleet operators are partnering with commercial vehicle manufacturers to jointly develop purpose-built EV models tailored to their business needs.

Key challenges	Recommendations
Lack of successful local reference cases *"We would like to see more success stories and reference cases in Hong Kong first. Otherwise, I am not confident enough to invest in electrifying my fleet."* *- commercial fleet operator.*	**L6 & L7:** Strong commercial vehicle success stories that are highly visible for the market to reference to would be beneficial. Large corporations, R&D and innovation bodies and the government in HK could take the lead by electrifying its own vehicle fleet or bringing and testing new vehicle and infrastructure models, being an early adopter and take the lead by electrifying its own vehicle fleet, setting an example for the rest of the market to follow. Promoting local success stories is key to boosting confidence in the transition to electric vehicles. Additionally, emerging business model such as "try before you buy" also gives fleets the opportunity to experience the benefits of electric vehicles. **Global case:** The UK government has established ambitious targets for electrification of its own fleet – all central government cars and vans (40,000 vehicles) are to be fully zero emission by 2027.
Charging infrastructure	
Insufficient charging infrastructure for commercial use and complex coordination in building chargers *"We do not have our own space for charger installation and there are not enough public charging facilities dedicated for commercial EVs."* *- local commercial fleet operator*	**L8, L9 & L10:** A multi-pronged approach is needed to develop a robust charging network for commercial vehicles to cater to the diverse needs and use cases of various market players. The industry should collaborate to identify suitable locations to develop public on-the-go charging & EV hubs. Providing necessary guidelines and support in increasing destination (commercial vehicle car parking, loading & unloading bays etc.) and workplace (depot, logistics hubs) charging for commercial vehicle. Other innovative uses of digital systems and charging technologies should also be encouraged. Furthermore, planning of charging should utilise data-driven analyses, understanding utilisation of existing charging sites as well as grid infrastructure capacity to enable efficient and accelerate smart charging infrastructure deployment. Lastly, interoperability and seamless facilitation of data across stakeholder will be key to enable a smooth end-user experience, in turn driving consumer confidence towards the eMobility market, leading to accelerated uptake of EVs. **Global case:** Singapore is set to host Southeast Asia's largest electric vehicle (EV) charging hub, operated by Volt Singapore. The new facility will have up to 80 fast-charging points for buses, taxis, private cars, and commercial EVs, making it the largest public fast-charging hub in the region. DigiKoo, a German company, has developed an innovative solution called DigiPAD to streamline the planning and implementation of electric vehicle (EV) charging infrastructure. The suite of applications provides municipalities and distribution system operators to quickly determine optimal locations for EV charging stations.

Key challenges	Recommendations
Economic consideration	
High upfront cost deterring operators from transitioning to EVs *"Although the total ownership cost might be lower, the upfront investment required is quite high and difficult to build a strong business case around" - commercial fleet operator*	**L11 & L12:** Financial and non-financial support should be prioritised and focused on the most high-impact and high-visibility use cases such MGVs and HGVs, where the upfront cost for the electric versions is significantly higher than the conventional fuel vehicles. Extending the funds available to test a wide range of operational modes is key to instil confidence in making the switch to commercial electric vehicles. Additional innovative business models such as Truck-as-a-Service that helps operator to avoid high upfront cost should be promoted. Traditional leasing business models will require a more developed and robust secondary market (i.e. battery recycling/repurposing) to improve commercially viability. **Global case:** Ryder System, a leading U.S. truck leasing provider, has successfully implemented a Truck-as-a-Service model to facilitate fleet operators' transition to electric vehicles. Their comprehensive package bundles electric trucks, charging infrastructure, maintenance, and related services into a single, streamlined solution. This approach has effectively addressed the challenges of high upfront costs and complex infrastructure requirements, enabling a smoother shift to EVs for numerous fleets[129].
Other challenges	
Lacks wider ecosystem to support EV uptake *"Currently, there are electric vehicle training programs offered by vocational and technical colleges (VTCs). However, more skilled labour will be needed to keep up with the future demands of electric vehicle repair and maintenance."* *- an EV industry association.*	**L13:** Targeted policies and initiatives should be established to facilitate the training and development of servicing and maintenance workforce and ensure seamless translation of skills from conventional to electric vehicles. Furthermore, the establishment of a robust local battery disposal and repurposing market could provide alternative business models for small and medium enterprises, improve the overall utilisation of end-of-life batteries. **Global case:** For 2023, the German government has budgeted €1.7 billion across multiple sectors to support and accelerate this upskilling effort. This substantial investment demonstrates the government's commitment to preparing its workforce for the demands of the evolving EV ecosystem, from manufacturing and maintenance to infrastructure deployment and service provision.

[129] Trucks-as-a-Service Model to Help Drive EV Adoption by Fleets

Key challenges	Recommendations
Policy and regulation	
Fleets ready for replacement, but uncertainty regarding direction *"No signal or policy direction on what technology will be supported, and we are hesitant to commit to any investments in electric vessels or charging facilities now"* *- a local harbour fleet operator.*	**M1 & M2:** The provision of clearly communicated and realistically achievable decarbonisation targets, along with a comprehensive roadmap that includes guidance on technology, should take into account the maturity of various technologies across specific use cases, given the diversity of vessel types operating in Hong Kong. A central taskforce is critical to coordinate the stakeholders and implementation. **Global case:** The Maritime and Port Authority of Singapore developed the Maritime Decarbonisation Blueprint in 2022, outlining several key actions to achieve its ambitious emissions reduction goals. These include transitioning all domestic harbour craft to low-carbon and eventually zero-carbon energy solutions by 2030, while adopting cleaner energy sources and automation in port terminals.
Lack of awareness of technology available in the market *"Electrification may not be suitable for us as our vessels need to operate at higher service speeds over longer ranges, and the time charter agreements have strict performance criteria, penalties and require uncertain hours of operation"* *- local harbour fleet operator.*	**M3:** Industry summits and conferences provide an excellent platform for stakeholders to connect, share knowledge and exchange experiences. Such events are invaluable in fostering dialogue and aligning efforts between shipyards and fleet operators to develop fit-for-purpose electric vessels. In addition to in-person forums, innovative virtual platforms can also drive industry-wide collaboration. **Global case:** In April 2024, Singapore hosted the Maritime Decarbonisation Asia Conference, attracting strong industry support and high-profile speakers from both public and private sectors, as well as international regulatory bodies. The conference enhanced awareness of maritime decarbonisation technologies and their practical applications, while addressing challenges and opportunities in the sector.
Operational feasibility	
Lack of local successful case hinders confidence *"We haven't seen electric boats in operation locally yet, and we are not sure if it will work in Hong Kong or not. We are waiting to see what the government does before we commit to any investments in this area"* *- local harbour fleet operator.*	**M4:** The government's own vessel fleet represents a valuable opportunity to demonstrate the feasibility of electrification to industry across multiple vessel segments. Organised publication and sharing of successful global and local reference cases and information regarding the latest developments will help spread awareness and encourage adoption of these technologies in Hong Kong. **Global case:** The Port of Auckland in New Zealand partnered with Damen, a leading shipyard, to design a custom electric tug tailored to their operational needs. The electric tug features a robust AC/DC Power Management System, enabling it to manoeuvre ships with a bollard pull of up to 70 tonnes, matching the performance of conventional diesel-powered tugs.

Key challenges	Recommendations
Charging infrastructure	
Underdeveloped charging infrastructure *"Our operations run 24/7 and require minimal downtime for charging. However, without reliable access to charging facilities, we are unable to ensure the continuous, uninterrupted operations that are essential for our business"* *- local harbour fleet operator*	**M5:** The provision of accessible and reliable charging infrastructure is a critical enabler for accelerating the widespread adoption of electric vessels. Policy makers could work with wider industry stakeholders to consider the unique requirements of different operators and incorporate a mix of shared and dedicated charging solutions strategically located throughout the harbour. Furthermore, approval process for installing charging facilities should be well-defined and streamlined with a focus to enhance interdepartmental collaboration and stakeholder communication. **Global case:** The city of Amsterdam has implemented an emission-free zone for boats and ships operating within its urban waterways. To support the transition to emission-free water transport, Amsterdam is investing in a network of public charging stations for electric boats and ships along the city's canals and waterways.
Supply and demand mismatch in shore power *"We're not seeing any demand for shore power, so the business case to invest in both deploying and operating the infrastructure is difficult to justify" - local shipping terminal operator*	**M6:** Accelerated investment in shore power infrastructure has the potential to enhance economic activity and protect Hong Kong's position as a leading global shipping hub. Given the complexity and capital-intensive nature of shore power, terminal operators in Hong Kong require clear guidance and robust financial support to effectively deploy the necessary shore power facilities. **Global case:** Mainland China's focus on delivering the 14th Five-Year Plan (2021-2025) to increase the utilisation of OPS by international shipping operators and cruise companies. Mainland China is particularly significant given the timing and scale of the deployment of OPS, and demand is expected to follow with many shipping operators and cruise companies retrofitting vessels to be shore power compatible.

Key challenges	Recommendations
Economic consideration	
High upfront capital costs in electric vessel and charging infrastructure *"The upfront cost of electric vessel and charging infrastructure are expensive. And who will bear the cost for charging infrastructure?"* *- local harbour fleet operator*	**M7, M8 & M9:** In terms of vessel electrification, financial support should be targeted at "high use" vessels with high fuel consumption and biggest impact on carbon emission reductions. Furthermore, subsidies will be crucial to support the necessary infrastructure development. Connecting to the financing community with the maritime industry to enhance the access to the required capital is also key. In additional, Public Private Partnership (PPP) allows government and industry stakeholders to collaborate would further unlock additional financing. Introduction of carbon trades could be another financial incentive worth investigating[130]. **Global case:** The New Zealand government has provided NZD 27 million to fund the construction of fully electric ferries in Auckland, building on the success of a pilot project in Wellington.
Other Challenges	
Lacks wider ecosystem to support E-vessel and shore power uptake	**M10:** To enable the widespread adoption of marine electric vessels and shore power in Hong Kong, a well-developed supporting ecosystem is crucial. This includes ensuring a skilled workforce capable of servicing and maintaining these advanced technologies, as well as establishing a robust local battery disposal and repurposing market. Targeted training and professional development programs, in collaboration with OEMs and industry stakeholders will be crucial to equip the existing workforce with the skills and knowledge to support the operation and upkeep of electric vessels and shore power infrastructure.

[130] The Hong Kong International Carbon Market Council (hkex.com.hk)

Policy and regulation

Challenge: Lack of certainty and signal

Industry stakeholders are currently adopting a "wait and see" approach due to a lack of a clear roadmap and targets for what they need to do and by when. Commercial vehicle fleet operators are currently planning to replace aging vehicles with new diesel-powered vehicles, which will remain in operation for the next 10 to 15 years. This poses a significant risk to Hong Kong's 2050 ambition, as any vehicles purchased in the next couple of years are likely to still be in operation at that time.

"We are interested in transitioning our fleet to electric vehicles, but we would like to see more clarity on the roadmap and incentives before fully committing to the electrification process."

- commercial fleet operator

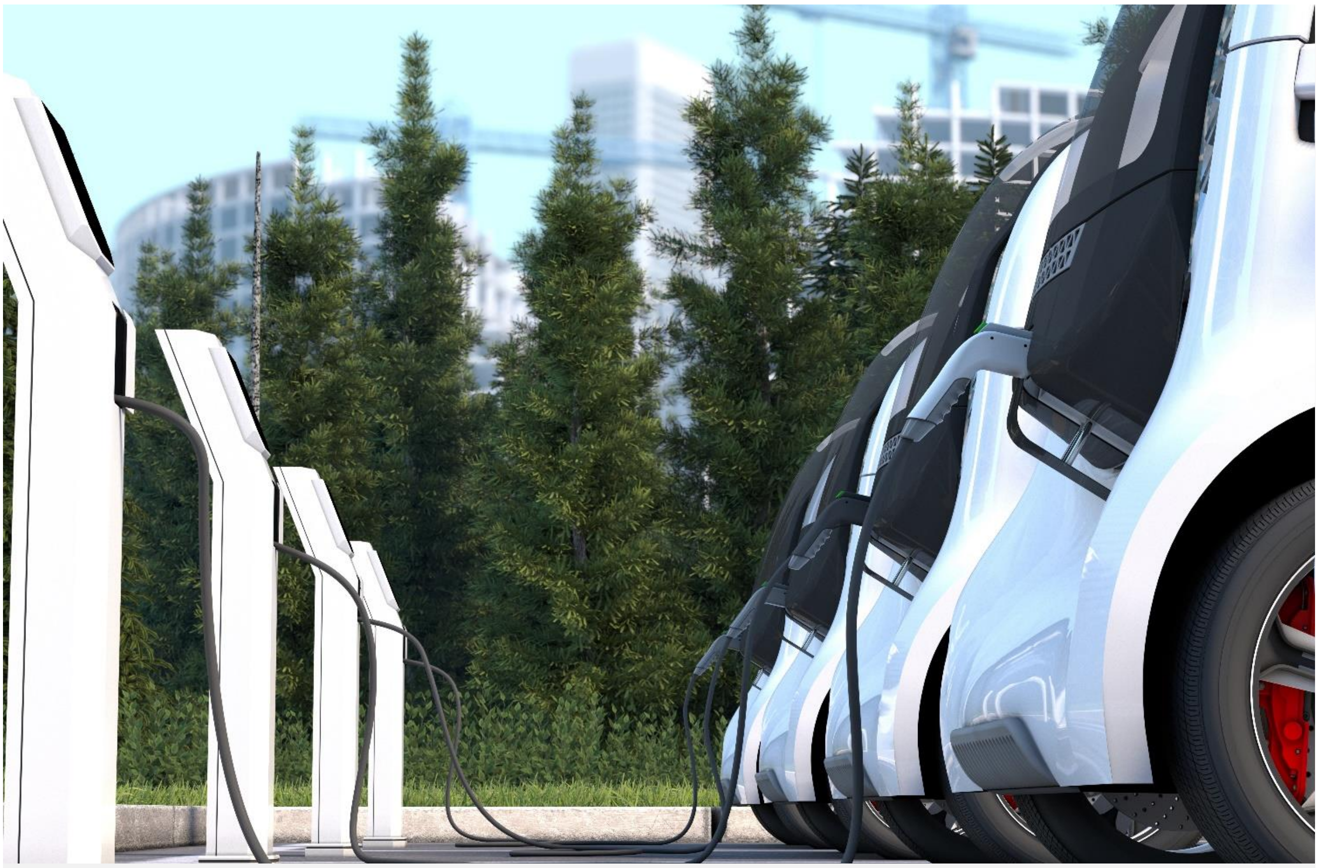
Recommendation L1: Develop segment level targets for near, medium and long term

To reduce market uncertainty and enable forward planning by the market, clear signals from policymakers are key. Near-term, medium-term, and long-term targets for decarbonising commercial vehicle fleets need to be defined and communicated transparently. Drawing insights from global case studies, defining achievable targets and communicating a comprehensive roadmap outlining what needs to be achieved and by when sends a strong signal to stakeholders, prompting them to respond accordingly.

From global case experience, Hong Kong could consider a phased approach to its targets. For example, the UK government has set targets to phase out non-zero emission commercial vehicles up to 26 tons by 2035, from 2040 all new HGVs with grants and subsidies provided for LGVs and MGVs[131]. A similar tailored approach for different vehicle segments could be beneficial for Hong Kong. By targeting LGVs and MGVs first, where the technology and total cost of ownership are more favourable, Hong Kong can deliver decarbonisation benefits earlier, accelerate the market where it is technologically and financially feasible, and build consumer confidence towards a self-sustaining green transport economy.

These clear signals in conjunction with a roadmap serve to provide stakeholders the confidence in operational viability of these zero-emission fuels and the long-term support of these technologies in the city; creating the certainty required to invest the high upfront costs required to enable this transition.

[131] Infrastructure for zero emission heavy goods vehicles and coaches - GOV.UK



Case study: Mainland China's ambitious targets and roadmap for electric vehicles - A leading example

Mainland China stands out as a pioneering jurisdiction with ambitious targets for electric vehicles (EVs), including commercial vehicles, set for the near, medium and long term at both national and provincial levels to achieve carbon neutrality by 2060.

In the near term, Mainland China aimed for a 20% sales share for New Energy Vehicles (NEVs) by 2025, a goal that has already been achieved. Looking to the medium term, Mainland China targets a 50% sales share of electric vehicles in "key air pollution control regions" by 2030, and a 40% sales share across the entire country by 2030 to support national objectives. Additionally, by 2030, Mainland China aims to establish a comprehensive charging network that spans urban, highway and rural areas.

The country's ambitious targets have generated a strong positive market response. In 2022, Mainland China led the global market for electric LGV sales, with over 130,000 units sold, representing nearly 15% of all LGVs sold in the country, according to IEA.

Source:
Trends in electric light-duty vehicles – Global EV Outlook 2023 – Analysis - IEA

Case study: Norway's successful roadmap in vehicle electrification

Norway has set ambitious targets for the future. By 2025, Norway aims for 100% of new passenger car, light van and city bus sales to be zero-emission. By 2030, the goal is for 100% of medium and heavy-duty vehicle sales and 75% of long-distance bus sales to be zero-emission.

To support these goals, Norway has implemented a comprehensive suite of economic and social incentives to promote the adoption of commercial electric vehicles. These measures include reductions on taxes, VAT exemptions, reduced toll road fees and free municipal parking and exemptions from transportation limitations regarding road usage and passenger numbers.

Additionally, there are mandates that all new cars and city buses procured by public entities must be zero-emission vehicles.

To remove key bottlenecks, the Norwegian government has also developed a national charging strategy, addressing the charging needs of various vehicle types. Being ahead of the game (and reaping its rewards), Norway has an organised charging network in place on all main roads, facilitating the transition to electric vehicles.

Source:
European Alternative Fuels Observatory
Norwegian EV policy
What Norway's experience reveals about the EV charging market

Key takeaways:

The Norwegian government have put in place all 3 major levers discussed in section 1 of this report, Policies & Incentives, Charging Infrastructure and Market Confidence, which collectively have all contributed to the success of its EV adoption.

Sending a strong signal to the market is a major contributing factor and may be of consideration to Hong Kong. Indicating support for transportation electrification will help market players understand Hong Kong's commitment and encourages their participation.

Recommendation L2: A central coordinating taskforce

Developing effective decarbonisation targets and roadmaps for the commercial vehicle sector requires strong coordination within the government and across industry stakeholders. Global best practices show that leaders in transport sector decarbonisation have set up an EV taskforce, a central coordinating body consisting of inter-departmental government and key industry stakeholders to accelerate effective local and national planning, streamlining permitting and implementation process, to enable efficient investment and introducing data-driven smart charging.

Crucially, these task forces are given the authority to drive change and innovation, set ambitious goals and standards to accelerate adoption. Hong Kong could establish such transport decarbonisation task force. This task force could bring the government, industry and experts together to accelerate transport to zero emissions, helping to shape future policy, creating influential initiatives and pilots.

Challenge: Outdated regulations and standards

The current legislative and regulatory framework in Hong Kong, designed primarily for conventional ICE vehicles, poses great challenges in accommodating the transition to electric vehicles (EVs), particularly for commercial vehicles. One example is the vehicle registration regulations, which have defined restrictions on weight, dimensions and other specifications. This has created complexity in meeting these requirements due to the battery weight and other technical aspects of EVs while fulfilling the operational needs of commercial EV applications.

"The weight of the battery pack in an electric truck has a significant impact on the actual payload capacity. For example, in a 5.5 tonne electric vehicle (EV) truck, we can only carry less than 1 tonne of goods, which is much less than a conventional diesel truck. This has a negative impact on our operational efficiency."

- a commercial fleet operator

The current zoning and land use regulations and timing could at times be prohibitive, limiting the ability for commercial fleet operators and charging infrastructure providers to repurpose land use with greater ambitions such as multi-storey EV hubs. Another deterrent cited has been the current land lease terms being between 10 to 15 years. This results in a limited timeframe for potential investors in infrastructure to recoup initial investment.

Recommendation L3: Review and streamline EV regulations and policies

The current legislative and regulatory regulations and policies are to be revisited and optimised to better accommodate the transition to electric vehicles (EVs). Some areas that require attention based on the comment from industry stakeholders are demonstrated in the table next page.

While there are other areas that warrant attention, the review and improvement of current EV regulations and processes should be the top priority. This effort should be led and proactively driven by an appointed government body or dedicated taskforce, in close collaboration with industry stakeholders. This centralised and collaborative approach would help optimise the regulatory framework and streamline the administrative processes, ultimately removing barriers to the commercial uptake of EVs and better accommodating the broader transition to electric mobility.

Focus areas	Key policy considerations
Commercial EV weight and payload capacity	The current regulations for commercial vehicles, defined in the Road Traffic Ordinance (Cap. 374), were designed with conventional ICE vehicles in mind. Regulations around vehicle and payload weight should be revisited to account for the inherently higher weight of electric trucks and buses compared to ICE counterparts due to battery, which can reduce payload capacity and impact operational efficiency without comprising the road safety.
Type approval standards and policies	Currently, vehicle types in Hong Kong are approved based on the requirements of the Road Traffic Ordinance (Cap. 374), which aligns more closely with European standards. However, given the surge of commercial EV models emerging from Mainland China, the type-approval evaluation framework in Hong Kong could be revisited and streamlined, particularly for Mainland and/or GBA accepted vehicles. Ultimately improving speed to market and the availability of commercial EV options in Hong Kong.
Charging infrastructure development	The development of charging infrastructure often involves coordination between multiple government departments and industry stakeholders, including landlords, charging service providers, utilities, and fleet operators. Streamlining permitting policies, reducing administrative barriers, and increasing interdepartmental cooperation on matters of land use and charging infrastructure would remove hurdles and encourage investment in charging infrastructure by stakeholders.

Case study: Streamlining regulations and incentives for zero-emission vehicles: EU and US initiatives

The EU plans to remove barriers and provide incentives for adopting zero-emission technologies and energy-saving devices in the HDV sector. One proposed policy allows zero-emission HDVs to **have extra weight and length**, compensating for heavier powertrains and providing additional loading capacity.

- Specifically, zero-emission HDVs will be permitted an extra four tonnes above the 40-tonne limit, encouraging investment in these vehicles.
- To support intermodal transport, extra height will be allowed for high-cube containers, with lorries, semitrailers and trailers benefiting from the same weight allowances.
- Furthermore, the permit application process for longer or heavier vehicles, such as those carrying indivisible loads or car transporters, will be streamlined. Regulations for overhanging loads will also be harmonised to ensure smooth cross-border operations.

The United States Environmental Protection Agency (EPA) has simplified the certification process for electric vehicles, reducing testing requirements and speeding up approvals due to their low emissions.

- In California, the "Electric Vehicle Charging Station Permit Streamlining Act" mandates local governments to expedite permitting for EV charging stations, including an easy online application and fast-tracked reviews for eligible projects.

Source:
European Commission Questions and Answers on Weights and Dimensions: new proposal to accelerate the uptake of zero-emission heavy-duty vehicles and promote intermodal transport, Heavy Payloads and Commercial EV Range

Operational feasibility

Challenge: Limited availability of suitable EV models in Hong Kong

Despite the growing global availability of electric commercial vehicles, Hong Kong currently lacks a sufficient selection of locally type-approved models. As of July 2024, the Transport Department has only approved 26 Electric Light Goods, 10 Electric Medium Goods and one Electric Heavy Goods Vehicles for use.

"There is a lack of available EV trucks that suit our operational needs, especially for medium and heavy goods trucks. There are only a few models in the market right now, and they are still very expensive."

- a commercial fleet operator

This limited model availability is due to Hong Kong's current small demand and lack of attractiveness for OEMs and distributors to bring more models into the market. Consequently, the restricted options do not adequately address diverse commercial use cases, causing fleet operators to express hesitation in transitioning to electric due to operational concerns.

"The type approval process sometimes can take more than half a year to complete. The process is complicated and the standards are stringent. This has delayed our progress in bringing more EV models into the market."

- a commercial EV distributor

Recommendation L4: Optimise processes to boost commercial EV model availability

The type-approval process in Hong Kong could also be streamlined to reduce time-to-market for EV OEMs, while maintaining best-in-class safety standards for citizens. Given the increasing number of commercially available EV models approved internationally, Hong Kong could consider accepting approval standards obtained from other countries, such as Mainland China, where many EV models originate. In fact, Chinese manufacturers currently produce the largest number of battery electric heavy-duty vehicle (HDV) models - over 430 in total. The number of Chinese companies producing electric HDVs has tripled from 12 to 36 between 2020 and 2023[132]. Given the rapid growth in the number and diversity of vehicle types in Mainland China, the type-approval evaluation framework in Hong Kong could be revisited and streamlined, particularly for Mainland and/or GBA accepted vehicles in its assessment of technology and safety.

Improving the availability of commercial EV options by leveraging international approval processes would drive consumer confidence and adoption in the Hong Kong market. This approach can also help Hong Kong, with its stringent type-approval standards, position itself as an international trade centre, being closely connected to the world for exporting EVs to other right-hand drive markets, taking advantage of the growing competition in the industry.

"The stringent type approval standards in Hong Kong are actually beneficial for OEMs. Once they meet these standards, it becomes easier for them to comply with regulations in other markets."

- an EV industry association

[132] Trends in heavy electric vehicles – Global EV Outlook 2024 – Analysis - IEA

Another potential solution is for the government and industry players to collaborate with vehicle manufacturers (OEMs) to bring in commercial electric vehicles (EVs) that are suitable for the Hong Kong market. To address the lack of model availability that fully meet the unique operational requirements in Hong Kong, the government has launched a Pilot Scheme for Electric Public Light Buses (e-PLBs), to subsidise a 12-month trial of around 40 e-PLBs on different routes[133]. This will help test the performance of e-PLBs and encourage charging service providers to install the necessary infrastructure. This pilot scheme is a good example of how the government can work with OEMs to boost the availability of suitable commercial EV models in the local market.

Recommendation L5: Foster industry partnerships to expand availability of suitable EV models in Hong Kong

Additionally, to increase awareness of commercial EV capabilities, Hong Kong should promote industry partnerships and bring ecosystem players into the local market to capture regional opportunities and improve model availability.

Industry partnerships can be a critical enabler for change, with market players coming together for mutual benefit. There have been numerous examples of fleet operators forming strategic partnerships with OEMs to enhance existing commercial model EVs to suit specific operational needs and contexts. Recent example include Sembcorp in Singapore has partnered with BYD to acquire fully electric garbage trucks, with BYD converting their existing electric garbage truck models to right-hand-drive to align with Singapore's road rules.

In Hong Kong, companies with small fleets can form alliances to enhance their collective purchasing power. Collaborating and coordinating orders allows allied companies to negotiate better terms with electric truck manufacturers, securing favourable prices and stable supply chains. The Fleet Procurement Program by The Electrification Coalition aggregates demand from multiple fleet operators, enabling participating fleets to take advantage of economies of scale and obtain competitive prices and terms from automakers and charging solution providers[134]. This model showcases how alliances can help smaller companies acquire electric trucks, fostering the adoption of cleaner transportation in Hong Kong's business landscape.

The industry partnership will increase the model availability in Hong Kong and provide confidence for OEMs to enter and invest into the market. Truck-as-a-Service (TaaS) is another viable collaborative option, allowing fleet operators to lease electric trucks and charging infrastructure from service providers. This reduces upfront costs and risks associated with ownership, making the transition to electric vehicles easier. TaaS providers handle maintenance, repair, and upgrades, enabling fleet operators to focus on their core business. By offering flexible and scalable solutions, TaaS can accelerate electric truck deployment in Hong Kong, complementing the benefits of industry partnerships and alliances in driving the shift towards cleaner transportation. For exploration of the Truck-as-a-Service (TaaS) business model and global examples,

[133] Hong Kong Roadmap on Popularisation of Electric Vehicles

[134] Electrification Coalition - EV Fleets

Case study: Industry collaboration in commercial EV adoption

Addressing limited electric commercial vehicle options through strategic partnerships

To tackle the challenge of limited electric commercial vehicle options, large corporations and fleet operators are partnering with commercial vehicle manufacturers to jointly develop purpose-built EV models tailored to their business needs.

For instance, UPS has partnered with commercial vehicle manufacturer Arrival to accelerate its fleet electrification, committing to purchase up to 10,000 EVs in the UK. IKEA has also collaborated with OEMs MAN to optimise electric last-mile solutions, addressing the need for larger vehicle dimensions suitable for furniture delivery, which are not yet mature in the market.

These partnerships enable corporations to influence vehicle design, ensuring that features such as range, payload capacity, and charging compatibility meet their specific requirements. This collaborative approach not only addresses their operational needs but also offers a highly competitive value proposition for companies.

Key takeaways:
Strategic partnerships between fleet operators and EV manufacturers have demonstrated effectiveness in overcoming the limitations of available commercial EV models. By fostering similar collaborations, Hong Kong can accelerate the development and adoption of electric commercial vehicles that meet specific local needs.

Source:
UPS Invests In Arrival, Accelerates Fleet Electrification With Order Of 10,000 Electric Delivery Vehicles
IKEA tests new electric vehicle prototypes

Case study: Mainland China EV100 Forum as a platform to share latest opportunities in land transportation electrification

The Mainland China EV100 Forum is a significant annual event that facilitates collaboration between government, OEMs, fleet operators, and other stakeholders in the electric vehicle industry. Here's how it promotes cooperation:

- **Platform for knowledge sharing:** The forum brings together experts from government, academia, industry, research institutes, and other organisations to discuss and promote the development of electric vehicles and intelligent connected cars. This creates an environment for sharing the latest technologies, policies, and market trends.
- **International cooperation:** The forum includes an international component, fostering global cooperation in advancing the development of the new energy vehicle sector. For example, it has collaborated with the UK's Department for International Trade for several years, hosting a UK-China EV session.
- **Industry insights:** Presentations from major players in the EV industry, such as GAC Aion and Great Wall Motor, provide valuable insights into the current status and future trends of the NEV industry.
- **Networking opportunities:** The forum provides a platform for networking among various stakeholders, potentially leading to new partnerships and collaborations between OEMs, fleet operators, and other industry players.
- **Showcasing innovations:** The event allows companies to present their latest technologies and innovations, which can be particularly beneficial for fleet operators looking to adopt new EV solutions.

By bringing together these diverse stakeholders and facilitating discussions on key industry topics, the Mainland China EV100 Forum plays a crucial role in promoting collaboration and advancing the electric vehicle industry in Mainland China and beyond.

Source:
EV Forum Saw Great Stakeholder Interest in International Cooperation
2024 China EV100 Forum: Development Trends of Intelligent EVs

Challenge: Lack of awareness of local successful case studies hinders confidence

Globally, TCO of EV commercial vehicles has been increasingly reaching parity with ICE, and in certain segments such as LGVs, already offer positive financial benefits and EY teams TCO analysis indicates that HK reflects these same trends, providing both economic and environmental advantages. Despite these benefits, HK faces inertia towards fleet electrification. Industry stakeholders cite a lack of visible local reference case studies, hindering their confidence to fully electrify their fleets in the HK context.

"We would like to see more success stories and reference cases in Hong Kong first. Otherwise, I am not confident enough to invest in electrifying my fleet." – a commercial fleet operator

There are successful case studies of early EV adopters in Hong Kong. An interviewed fleet operator expressed that they are very satisfied with their new electric vehicles - they're saving on fuel and maintenance and can deliver cargo without tailpipe emissions. This operator wants to expand their EV fleet but notes the public charging network need to improve before it will be operationally viable to do so. Unfortunately, these real-world success stories aren't widely shared to encourage other fleet operators. More needs to be done to highlight the benefits experienced by pioneers, to build industry confidence in commercial EV fleets.

"We really like the new 5.5 tonne electric truck fleet. The range is satisfactory and we've saved a significant amount on fuel operating costs, and we can keep the ignition running to support the temperature-controlled storage while stopping without any tailpipe emissions." – a retail fleet operator

Recommendation L6: Prioritise corporate, quasi-public and government fleet electrification

Hong Kong requires strong success stories that are highly visible for the market to reference. Globally, many governments, as part of their transport decarbonisation journey, have committed to being early adopters of electric vehicles, setting a positive signal for the rest of the industry.

Hong Kong could also take the lead by electrifying its government vehicle fleet of close to 7,000 vehicles, providing confidence and demonstrating the viability of commercial electric vehicle adoption. Similarly, government procurement of transport related services could also start mandating zero-emissions as a key selection criteria, prompting impactful change from vendors.

Beyond government fleets, quasi-public fleets could also be targeted for early electrification. Additionally, certain fleet operators, such as those with LGVs, their own parking facilities, and global companies with ESG mandates, are more likely to transition towards fully electric fleets first. Capturing these early electrification opportunities will be critical for Hong Kong. Large corporations and innovative companies that are looking to take advantage of the financial and sustainability benefits should also be looking to develop business plans and operational feasibility assessments.

Highly visible public local success would help lower the perceived barriers to entry and accelerate the mainstream acceptance of zero-emission commercial transportation solutions, demonstrating the tangible benefits that can be captured through the strategic deployment of commercial electric vehicles and driving wider adoption across the industry.

Case study: UK government's ambitious targets and initiatives to electrify its own fleet

The UK government has set ambitious targets and implemented several initiatives to support the electrification of its own fleet as well as business fleets. Here's an in-depth look at the measures taken to achieve these goals:

Government fleet electrification targets

- **100% zero emission by 2027:** All central government cars and vans are to be fully zero emission by 2027, impacting approximately 40,000 vehicles. This demonstrates the government's commitment to leading by example in the transition to electric vehicles (EVs).

Initiatives to support government fleet electrification

- **Zero emission fleets local authority toolkit**: Developed to assist local authorities in transitioning their fleets to zero emission vehicles, this toolkit is crucial for ensuring local government fleets align with national targets.

Infrastructure and economic support

- **Grant Schemes:** Various grant schemes are available UK-wide to support the adoption of EVs and the development of charging infrastructure. These grants are essential for reducing the initial cost barriers to electrification.
- **Workplace Charging Scheme (WCS):** Offers businesses up to £350 per charging socket, with a maximum of 40 sockets, to encourage the installation of EV charging points at workplaces. This also benefits government offices and facilities, promoting a seamless transition to EVs.

Key takeaways:

The UK government's initiative to electrify its own fleet can act as a prominent and impactful local success story. By showcasing the concrete benefits of zero-emission vehicles, perceived barriers can be reduced and speed up the widespread acceptance of zero-emission commercial transportation solutions. This strategic implementation highlights the practicality and advantages of electric vehicles in everyday use, encouraging broader industry adoption.

Source:
The UK Government: Transitioning to zero emission cars and vans: 2035 delivery plan
The UK Government: Taking charge: the electric vehicle infrastructure strategy
Electric vehicles and infrastructure - House of Commons Library
2024 Guide To Electric Vehicle Charging Grants

Recommendation L7: Launch pilot programmes such as "try before you buy" to boost operator's confidence in technology

To further increase confidence, Nottingham City Council[135] offered a trial program that allowed local fleet operators to test commercial EVs before committing to investment. This "try before you buy" approach removes a significant barrier to adoption and gives fleet operators the opportunity to experience the benefits of electric vehicles firsthand.

Promoting local success stories is key to boosting confidence in the transition to electric vehicles. The government could consider working with industry stakeholders that are hosting dedicated forums (such as the eMobility Network, Business Environment Council, etc.) and seminars that provide a platform for industry stakeholders to share their real-world experiences, best practices and seek out collaboration opportunities. Highlighting these positive case studies and providing hands-on experiences are crucial steps to accelerating electric vehicle adoption across the commercial sector. Building that confidence through tangible proof points will be essential to driving widespread transition and uptake.

Case study: Try-before-you buy program offered in Nottingham

Nottingham City Council has announced a £2.69 million investment to offer businesses in the region free trials of new electric vans. The council will purchase 50 electric vans, including medium and long-wheelbase vehicles, that companies can use on a "try-before-you-buy" basis until March 2022.

The funding, which came from the Highways England's Air Quality Fund, will also cover the costs for businesses to install charging equipment, as well as the setup of two charging hubs and vehicle telematics, booking-management systems, in-car cameras and performance data.

This initiative is part of Nottingham's efforts to improve air quality and work towards its goal of becoming the UK's first carbon-neutral city by 2028.

Key takeaways:

This free electric van trial program can help boost businesses' confidence in transitioning to electric vehicles. By allowing them to test out the vehicles at no upfront cost, it removes a significant barrier to adoption and gives them the opportunity to experience the benefits of electric vans firsthand.

Source:
Nottingham City Council to invest £2.69m into electric vans to give free trials to firms - Powersystems UK Ltd

135 Nottingham City Council to invest £2.69m into electric vans to give free trials to firms - Powersystems UK Ltd

Charging infrastructure

Challenge: Early stages of charging infrastructure development for commercial use and complex coordination in building chargers

Globally, there has been a shift in consumer sentiment from "range anxiety" to "charging anxiety" as evolving EV technology has addressed range concerns, but the uncertainty around availability and accessibility of chargers remains a critical challenge. Hong Kong fleet operators have expressed similar concerns, with the availability of charging facilities suitable for their operational needs being a top consideration for electrification.

> *"We do not have our own space for charger installation and there are not enough public charging facilities dedicated for commercial EVs."*
>
> *– local commercial fleet operator*

According to the EY team's analysis in the previous section, around 39,000 chargers are needed across workplace and destination sites, while circa 2,500 public on-the-go chargers are needed by 2030. However, the current and planned charging installations are catering primarily to the needs of private car owners rather than commercial vehicles. As such, urgent planning will be needed to determine the appropriate future charging investment that aligns with the priorities of different vehicle segments.

Adding to this complexity is the involvement of multiple stakeholders in developing charging infrastructure, including utilities, landlords, property developers and various government bodies. The underlying interdependencies and substantial investments needed from the private sector to develop a robust charging network create significant challenges. Without the right incentives and a streamlined coordination process, stakeholders may be reluctant to invest in scaling up the necessary charging capabilities, further exacerbating the issue.

The implication of this charging infrastructure challenge is a lack of confidence among fleet operators to transition to electrification, thereby slowing down the decarbonisation progress in Hong Kong.

Recommendation L8: Develop a robust charging network for commercial vehicles

A multi-pronged approach to charging infrastructure development is required to support this transition to cater to the diverse needs and use cases of various market players. The below will require a collective effort and close collaboration amongst government, industry and utility players in Hong Kong:

On-the-go charging: Collaboration amongst industry and government to plan public charging hubs at strategic locations (similar to recent petrol station sites auctioned by the government[136]). Develop a robust network of fast-charging facilities, including those dedicated solely for commercial use to avoid competition with passenger vehicles. Suitable locations as suggested by industry stakeholders include but not limited to

- Industrial estates such as Tai Po, Fo Tan, Kwun Tong, Yuen Long, and similar commercial and industrial hubs
- Major on-route destinations like the Kwai Tsing container terminals and the Hong Kong International Airport
- Loading and unloading bays in key commercial areas, shopping malls and logistics centres
- Other underutilised public spaces located in close proximity to high commercial traffic zones such as major flyovers across Hong Kong

In the 2024 policy address, the Hong Kong Government earmarked HK$300 million for the

[136] news.gov.hk - Tenders for charging station invited

private sector to install quick charging facilities, a scheme that industry players should take advantage of to install quick chargers in private premises.

Destination and workplace charging: With the success of the EV Charging at Home Scheme (EHSS) in home charging, a similar scheme may be considered for dedicated commercial charging infrastructure at destination and workplace locations to reduce financial burden for operators and/or landlords and property developers. The design of the subsidy program and/or cost sharing framework should be used as an opportunity to streamline currently complex end to end processes - from application to installation and maintenance of chargers.

Innovation in charging technology: Relevant R&D bodies such as Hong Kong's Productivity Council, Hong Kong Logistics and Supply Chain MultiTech R&D Centre etc. and/or academia could encourage a collaborative environment that enables companies and innovators to trial and test their new charging technologies, such as mobile charging solutions and battery swapping systems as well as implement standardised, interoperable digital systems to enable data capture. This can support new services and business models, like the Optimise Prime program's efforts (please refer to case study in following sections) to analyse charging data to understand charging behaviour in order to optimise the grid for commercial fleet operation[138].

By taking a holistic, long-term approach to charging infrastructure, Hong Kong can create a future-proof ecosystem to support the transition to electric commercial vehicles.

Case study: Global EV hubs catering the growing demand for EV infrastructure

Singapore is set to host Southeast Asia's largest **EV charging hub**, operated by Volt Singapore. The new facility will have up to 80 fast-charging points for buses, taxis, private cars and commercial EVs, making it the largest public fast-charging hub in the region. The first phase is expected to be operational in the first half of 2026, featuring charging points with 360 kW and 120 kW ratings, allowing for charging times as fast as 10 minutes.

Singapore's large-scale deployment of charging infrastructure is significantly contributing to the country's fleet electrification efforts. Under an initial pilot program run Land Transport Authority, two tenders were awarded to install over 600 EV charging points across more than 200 public car parks in Singapore. This pilot program has since been scaled, with an additional five awarded tenderers set to deploy 12,000 charging points across 2,000 carparks across Singapore.

The **Nottingham City Council in UK** has established a state-of-the-art municipal **EV charging depot** that exemplifies sustainable fleet management. The facility is home to 250 EVs, including six all-electric waste lorries, demonstrating the council's unwavering commitment to electrification[137].

The depot has integrated advanced battery storage systems to optimise the use of solar energy generated on-site. This allows the facility to store energy during off-peak hours and utilise it to power the site and charge the fleet, thereby significantly reducing energy costs by avoiding peak tariffs.

Key takeaways:
Implementing a coordinated large scale EV charging hubs can accelerate the deployment of charging points across public areas in Hong Kong. Additionally, utilities company can integrate energy storage systems and renewable energy sources to optimise energy use and reduce costs.

Source:
Award of Singapore's pilot electric vehicle charging infrastructure tender
Speech by Minister For Transport Mr S Iswaran at the Launch of the National Electric Vehicle Campaign "Power Every Move: Towards An Ev-Ready Future"
LTA | More Electric Vehicle Charging Points to be Deployed in HDB Carparks
Nottingham City Council's Eastcroft Depot Launches New Vehicle-To-Grid (V2G) Demonstrator Project
Nottingham now home to one of UK's largest V2G installations - electrive.com

Recommendation L9: Establish standards and data interoperability

Digital infrastructure and data standards have become increasingly prevalent as global eMobility markets mature. Global consensus indicates that digital infrastructure and data standards serves as the foundation of an efficient eMobility market as it facilitates ecosystem planning and management, as well as the quality of user experiences through digital applications.

EY's report on "*How do we solve the challenge of data interoperability in e-mobility?*", in collaboration with eurelectric[139] found that data interoperability can optimise critical ecosystem activity through the following:

- **Charging station optimisation:** Efficient planning of strategically located charging stations, which are accessible, renewably powered (where possible), reliable and scalable
- **Intelligent grid integration:** Seamless integration of EV charging with the energy grid for flexibility purposes
- **Optimised charging experience:** User-friendly, consistent and seamless access to charging infrastructure across different charging networks

The government could also help to support the ecosystem by implementing regulations and standards that support data exchange. The UK regulations for EV smart charge points, require that charge points sold for private use in Great Britain include smart functionality and meet specific safety and interoperability standards[140]. These regulations aim to manage increased electricity demand from the transition to EVs and ensure consumer access to secure and informative charging options. In the EU, there have been various regulations implemented, including the Renewable Energy Directive[141] (RED), AFIR[142], the Energy Performance of Buildings Direction[143] (EPBD) and the Data act[144], to collectively allow data to flow and be exchanged, enabling services such as bidirectional charging, roaming and support for drivers in locating available charging infrastructure. These standards and communication protocols are the building blocks for efficient and safe communications in the EV charging ecosystem solving the following challenges:

- **Charging connector standards:** Different regions and vehicle manufacturers have adopted different charging connector standards, such as Combined Charging System (CCS), GuoBiao (GB) and CHAdeMO. This diversity can lead to compatibility issues for EV users
- **Smart charging features:** A lack of standardised protocols for demand response and grid integration, and other smart charging capabilities, may limit the potential benefits of a smart and flexible charging infrastructure.
- **V2G standards:** Non-standardised protocols for vehicle-to-grid (V2G) communications and integration with the electrical grid can limit the widespread adoption of bidirectional charging and energy sharing.
- **Software updates and upgrades:** With over-the-air software updates becoming commonplace for EVs, standardised processes are needed for secure and efficient updates across different vehicle models and manufacturers.
- **Pace of innovation:** Standardisation efforts, and the pace of technological innovation in the EV industry, must align to avoid fragmentation and potential obsolescence of some technologies

This would form the basis for industry stakeholders to utilise that data to develop new business models, service offerings, driving the overall consumer experience. These offerings may include roaming and payment solutions which denotes EV drivers' freedom to charge their vehicles at any charging station irrespective of charging network, using a single app, account or payment method.

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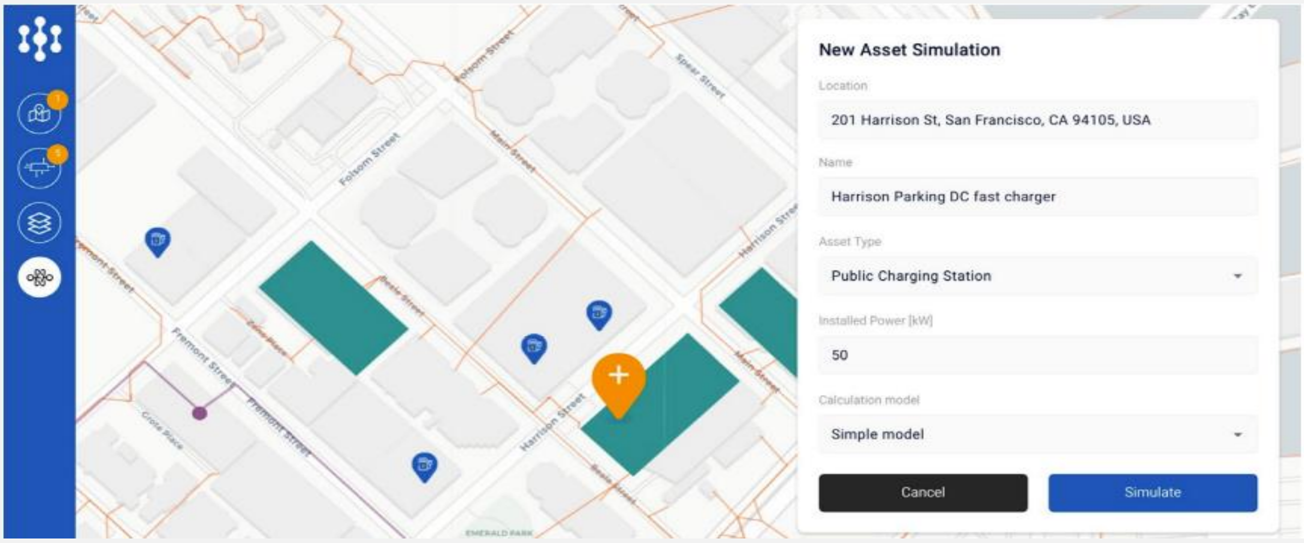
[139] EY-Eurelectric-data-interoperability-study-2024-_FINAL.pdf
[140] Regulations: electric vehicle smart charge points - GOV.UK (www.gov.uk)
[141] Directive - EU - 2023/2413 - EN - Renewable Energy Directive - EUR-Lex (europa.eu)
[142] EUR-Lex - 52021PC0559 - EN - EUR-Lex (europa.eu)
[143] New rules to boost energy performance of buildings (europa.eu)
[144] Regulation (EU) 2023/2854 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act) - European Sources Online



Case study: Digikoo eMobility Data to plan charging infrastructure

DigiKoo, a German company, has developed a groundbreaking solution to streamline the planning and implementation of electric vehicle charging infrastructure for municipalities and distribution system operators (DSOs) and charging operators.

The Challenge
In Germany, planning charging infrastructure in line with grid infrastructure capacities. Obtaining the necessary grid information to assess the feasibility of a proposed EV charging station location was a time-consuming process. This delay posed a significant barrier to achieving substantial reductions in CO2 emissions.

The Solution
DigiKoo developed a suite of applications called DigiPAD, which provides recommended locations to users to quickly determine the optimal locations for EV charging stations.

Results and Benefits
By utilising the DigiKoo applications suite, users can efficiently generate recommendations for EV charging station locations. This resulted in significantly streamlining the planning process. DigiKoo's solution not only expedites the implementation of EV charging networks but also ensures compliance with German regulations. In addition, the grid operator can also benefit from better visibility, enabling better planning of an efficient grid.

Key takeaways:
The success of DigiKoo in Germany highlights the importance of leveraging data and technology to overcome the challenges associated with planning and implementing EV charging infrastructure. This platform should prioritise data security, privacy, and compliance with local regulations while ensuring interoperability between different datasets and system.

Source:
[DigiKoo: data-driven planning for EV charging stations - Intertrust Technologies]

Challenge: Additional power supply required in existing premises to support larger scale transport electrification

Given the significant future commercial EV uptake and charging demand forecast we outlined in Section 2, it is imperative that fleet operators, policy makers, utilities and other industry players work closely together to address the needs and accommodate the growing demand.

Currently, fleet operators across our study have raised concerns on potential upgrade works of existing infrastructure and additional spacing requirements to cater for the potentially larger charging requirements from the commercial vehicles segment. Often premises are rented on a short-term basis by the operator, with little incentive to invest in additional supply infrastructure. While some other operators require more data to understand the future demand of charging to evaluate the infrastructure upgrade need. This mismatch between supply and projected demand requires coordinated action from all stakeholders.

"We have currently maxed out our power supply, but upgrading is costly as we have to house the new substation and it will take some time to complete."

– property landlord

The delineation of responsibilities and misaligned incentives among different stakeholders involved pose additional challenges in coordinating the necessary actions to address the growing demand for power from EV charging. While fleet operators recognise the need for electrification, the property owners would need to work with utility providers to upgrade the grid infrastructure and install the necessary charging equipment. However, property owners may lack the same incentives as the fleet operators to invest in these upgrades, and without proper incentives or a clear framework for cost-sharing, they can be reluctant to make the required investments.

Case study: Utilities as market facilitators to address grid challenges and infrastructure development for commercial EVs

The large-scale adoption of electric vehicles (EVs), especially commercial ones, can pose challenges for power networks due to increased electricity demand, potentially requiring grid reinforcements, if charging takes place simultaneously at peak times.

In the UK, the Optimise Prime program, led by Hitachi with industry stakeholders including distribution network operators (DNOs) and commercial EV fleet operators, is conducting field trials to understand these effects. By monitoring thousands of EVs, the program aims to model the impact on the power grid and trial innovative mitigation strategies, such as profiled connection agreements and flexibility services. These strategies will help fleet operators and DNOs manage the transition to electric transportation effectively.

Key takeaways:

The collaboration between utilities, industry players and government to collectively share data and plan ahead is an effective way to accelerate the development of a robust charging network for commercial EVs. By working together, the industry can develop solutions that address the grid impacts of large-scale EV adoption and ensure a smooth transition to electric transportation.

Source:
[About – Optimise Prime (optimise-prime.com)]

Recommendation L10: Utilities as market facilitators to work with policy makers and eMobility ecosystem to facilitate and plan infrastructure development and EV adoption

Industry stakeholders have expressed a strong interest in participating in the decarbonisation transition but require additional support in charging infrastructure and charging solutions.

Grid planning and integration: Utilities play a critical role in supporting the scalable transition of EVs. At the core of this is ensuring efficient grid integration and sufficient power transmission infrastructure to accommodate the high-power demand from commercial vehicle charging.

Thus, it will be crucial to plan, design and implement various measures to minimise the impact of EV charging on grid congestion, thus optimising the need for network reinforcement, and reducing impacts on tariffs:

- Improving grid forecasting and monitoring capabilities to gain a clear understanding of expected EV penetration and load growth across geographical areas;
- Continue digitising and deploying smart grid technologies (smart-metering, managed charging solutions etc.) to optimise network use;
- Invest strategically in network upgrades/grid capacity allowing customers the freedom to charge affordably.

Managed Charging Solutions – Time of Use Tariffs (ToU): Optimising smart charging through user-enabled managed charging such as EV time-of-use (TOU) tariffs, is critical in reducing investments in augmenting grid infrastructure and incentivising the adoption of commercial electric vehicles (EVs) and vessels. The power needs of these sectors are significant and should be assessed, with appropriate ToU tariffs made available to them.

Additionally, Utilities and policymakers should review smart charging regulations and solutions to better align with the charging needs of commercial EVs and marine vessels. This may involve extending off-peak periods to cover overnight hours, introducing demand charges to encourage load management, offering discounted rates and earlier connection date for managed charging,

Digital and smart grid capabilities: In parallel, utilities should also encourage the deployment of smart grid capabilities such as vehicle-to-grid or supplier-enabled charger management systems to maximise energy management. Key actions may include:

- Develop V2G trial to understand grid integration efficiencies at scale;
- Secure flexibility services from V2G capable EVs in order to manage peak demand and defer network upgrades.

Moving forward, utilities in Hong Kong should continue to act as market facilitators, providing necessary grid infrastructure and customer solutions to enable the transition, as well as working closely with the government and the industry to ensure the right priorities are addressed.

Case study: How self-organised groups are driving initiatives and pilot studies in heavy-duty electric vehicle charging

CharIN is a global association with over 200 members from across the automotive, charging hardware and software, and energy industries. This self-organised group is working to promote and establish the Combined Charging System (CCS) as the global standard for charging electric vehicles.

One of CharIN's most significant initiatives is the development of the **Megawatt Charging System (MCS)** for heavy-duty electric vehicles. This system aims to enable fast charging for large electric trucks, reducing downtime and making long-haul electric trucking more feasible. This project showcases how cross-industry collaboration can drive innovation and standardisation in electric mobility.

Key aspects of the MCS initiative:

- **Standardisation efforts:** Ensuring interoperability across different vehicle and charger manufacturers and coordinating with international bodies like ISO and IEC.
- **Testing and validation:** CharIN organises "TestVal" events where member companies bring prototype vehicles and chargers to test interoperability.
- **Grid integration studies:** Utility members of CharIN are conducting studies on the impact of high-power charging on the electrical grid.
- **Pilot projects:** Several CharIN members are collaborating on pilot projects to test MCS in real-world conditions. For example, Daimler Truck, BlackRock Renewable Power, and NextEra Energy Resources are planning $650 million joint venture to deploy a network of charging sites for medium and heavy-duty electric vehicles across the United States[145].
- **Policy advocacy:** CharIN engages with policymakers to promote supportive regulations for high-power charging infrastructure including funding programs and streamlined permitting processes.
- **Cross-sector knowledge sharing:** The initiative facilitates knowledge sharing between automotive OEMs, charging equipment manufacturers, and utilities.

[145] Joint Venture for public charging infrastructure in the U.S. | Daimler Truck

Case study: V2G Implementation - Project Sciurus in the UK

One of the most notable implementations of Vehicle-to-Grid (V2G) technology is the Project Sciurus in the UK, which represents the world's largest domestic V2G trial. This project was a collaboration among four UK businesses, including Cenex, funded by the Department for Business, Energy & Industrial Strategy and the Office for Zero Emission Vehicles. The trial aimed to accelerate the transition to electric vehicles (EVs) and address the challenges of integrating EVs into the grid.

Financial benefits: Participants could earn up to £725 per year from V2G services, significantly higher than the £120 savings from one-way smart charging. This was achieved by optimising charging times and exporting energy back to the grid during peak demand.

Technology and platform: The V2G devices were managed by Kaluza's intelligent energy platform, which optimised charging at the greenest and cheapest times and provided grid balancing services.

Consumer acceptance: The trial alleviated major concerns about battery degradation, reliability and costs. Participants expressed a strong interest in ensuring their next EV had V2G capability, indicating a positive reception to the technology.

Cost considerations: The initial hardware and installation costs were around £3,700 higher than a standard smart charge point, but with mass production, this cost is expected to decrease significantly, making V2G more economically viable.

Key takeaways:

- **Financial incentives:** Providing financial incentives and subsidies to offset the initial costs of V2G infrastructure can encourage adoption among EV owners.
- **Consumer education:** Addressing consumer concerns through education and transparent communication about the benefits and functionalities of V2G can enhance acceptance and participation.
- **Grid integration:** Collaborating with energy companies to develop intelligent energy platforms that optimise V2G operations can help balance grid demand and supply, especially with the integration of renewable energy sources.
- **Policy support:** Implementing supportive policies and regulations that encourage the adoption of V2G technology can drive the transition towards a more sustainable energy ecosystem.

Source:
World's largest domestic Vehicle-to-Grid trial
Vehicle-to-grid (V2G) technology: Key challenges and developments

Economic consideration

Challenge: High upfront cost

The upfront acquisition cost of electric commercial vehicles remains significantly higher than their conventional diesel counterparts, often ranging from one to four times more expensive. This is mainly due to the higher battery capacity requirements and limited supply and demand in the current market. Furthermore, the investment in dedicated charging facilities is another major cost consideration for fleet operators, deterring many from transitioning to electric vehicles. Additionally, the lack of a mature battery recycling ecosystem in Hong Kong means the cost of responsible battery disposal must be factored in, further challenging the business case for electrification.

As discussed in Section 2, the total cost of ownership for electric vehicles can be favourable compared to conventional ICE vehicles, largely due to reduced fuel and maintenance expenses. Despite the potential for lower long-term operating costs, the high upfront acquisition cost remains a key deterrent for the electrification of commercial vehicles.

"While the lifetime cost of EVs might be lower, the upfront investment required is still quite high, and remains a critical consideration for our business"

- commercial fleet operator

Recommendation L11: Targeted levers and incentives to accelerate commercial vehicle electrification

Subsidies are crucial for accelerating the electrification of commercial vehicles in Hong Kong. Given resource constraints, the financial support should be prioritised and focused on the most high-impact and high-visibility use cases to drive this agenda effectively. One such area is MGVs and HGVs, where the upfront cost for the electric versions is significantly higher than their conventional ICE counterparts, and the emissions are also higher compared to other light and passenger vehicles. Providing financial and non-financial incentives for the electrification of MGVs and HGVs can be an impactful way to drive the adoption of these technologies.

The current government NET (New Energy Transport) fund has been instrumental in kickstarting commercial EV pilots. However, the limited scope and quota of this fund may not sufficient to incentivise wider adoption of commercial EVs given the wide range of operating modes and models of commercial fleet operations. Fleet operators have expressed concerns that the funding is difficult to access, and the total funding amount has even been recently reduced. To drive a more substantial transition to commercial electric vehicles, the further considerations in scaling up the NET fund. Expanding the program's budget and eligibility criteria would allow more commercial fleet operators to access these financial incentives, testing a wide range of operational modes and support the switch to EVs.

Beyond direct incentives for vehicle acquisition, the government could work with the industry in enabling the development of public charging infrastructure, particularly for the commercial vehicle sector. This can be enabled through streamlined processes, facilitation of stakeholders and clear guidelines. Commercial fleet operators require dedicated, exclusive charging spaces to avoid competing with the public for charging points. Additionally, commercial property landlords are interested in supporting the transition but are hesitant to invest in charging infrastructure without the certainty of demand. Enabling landlords and reducing their administrative and infrastructure costs should also be considered to address this "chicken or egg" scenario.

Some emerging business models, such as "Truck-as-a-Service," exist globally to help commercial vehicle operators overcome the high upfront investment challenges. These innovative business ideas should be promoted in the local Hong Kong market to further accelerate the electrification transition. By prioritising subsidies, incentives, and supporting novel business models, Hong Kong can more effectively drive the electrification of its commercial vehicle fleet.

Case study: UK government's push for electrification of commercial vehicles through subsidies

The UK government is intensifying efforts to electrify commercial vehicles, focusing on LGVs and MGVs. It has announced an expanded vehicle purchase grant program with £582 million in funding:

- Grants of 20% of the purchase price: Up to £16,000 for vehicles between 3,500kg and 12,000kg gross weight
- Grants of 20% of the purchase price: Up to £25,000 for vehicles above 12,000kg gross weight

This financial support aims to make the transition to electric LGVs and MGVs more affordable for businesses. Additional support includes the workplace charging scheme, corporation tax incentives and exemptions or discounts on congestion and emissions zones.

By enhancing its commitment to commercial vehicle electrification, the UK government aims to accelerate the decarbonisation of this sector, making the switch to electric vehicles more viable and attractive for businesses.

Key takeaways:
In addition to direct subsidies, offer complementary support like the workplace charging scheme, tax incentives and exemptions or discounts on congestion and emissions zones to reduce operational costs for businesses.

Source:
BETT - Battery Electric Truck Trial

Recommendation L12: Encourage innovative business model through industry collaboration

Industry: Emerging business models, such as Electric Truck-as-a-Service (TaaS) and Battery-as-a-Service (BaaS), are already gaining popularity globally. These models are particularly relevant for the commercial vehicle sector, where the high upfront cost of medium and heavy-duty electric trucks can be a significant barrier to adoption.

TaaS and BaaS models make it easier and faster for fleet operators to transition to electric trucks. Through a single provider, businesses can acquire the vehicles, access charging infrastructure, and manage maintenance – all on a monthly subscription basis. This "pay-as-you-go" approach helps fleet operators overcome the financial hurdles associated with EV adoption.

To support the widespread uptake of commercial EVs, the government and large conglomerates could enable the adoption of these innovative business models, for example by being a first of its kind customer in the city. While fleet operators should partner with other operators, OEMs and industry groups to collectively explore opportunities for collaboration and mutual benefit.

Case study: Emerging business models for electric truck services

Innovative business models like Electric Truck-as-a-Service (TaaS) provide companies with a viable alternative to avoid the high upfront and maintenance costs associated with vehicle ownership. Such business model may offer Hong Kong a practical approach to reduce financial barriers associated with transitioning to electric vehicles. Companies are easier to integrate electric vehicles into their fleets. These models significantly contribute to the decarbonisation of transportation by offering a cost-effective and sustainable solution for businesses.

For example, WattEV in the US offers an Electric Truck-as-a-Service (TaaS) model. This model allows fleet operators to access electric commercial vehicles at a per-mile or per-route rate, including the cost of the vehicles, charging infrastructure, installation and maintenance. Ryder System, a prominent U.S. truck leasing company, their comprehensive offering integrates electric trucks, charging facilities, and maintenance services into a single, user-friendly package. By addressing the challenges of substantial initial investments and intricate infrastructure requirements, this strategy simplifies the adoption of EVs for numerous fleet operators. These innovative service-based models help mitigate the high upfront costs, making electric commercial vehicles more accessible and viable for fleet operators in Hong Kong.

Source:
WattEV to break ground on California's first solar-powered "electric truck stop"
Trucks-as-a-Service Model to Help Drive EV Adoption by Fleets - Equipment - Trucking Info

Other challenges

Challenge: Ecosystem lacks comprehensive support

Enabling widespread commercial EV adoption in Hong Kong requires more than just EV technology and charging infrastructure. A skilled workforce capable of servicing and maintaining these advanced vehicles, as well as a mature battery disposal and repurposing market, are also crucial components of a comprehensive supporting eMobility ecosystem.

> *"Currently, there are electric vehicle training programs offered by vocational and technical colleges (VTCs). However, more skilled labour will be needed to keep up with the future demands of electric vehicle repair and maintenance."*
>
> *- an EV industry association*

Currently, Hong Kong has limited training and development programs for EV servicing, and a EV battery disposal and recycling ecosystem is yet to be established. While these may not be immediate considerations for electrification decisions, they will be crucial to maintaining a healthy and sustainable EV ecosystem in the long run.

Recommendation L13: Targeted initiatives to support wider EV ecosystem

While organisations like the Vocational Training Council (VTC) have begun offering professional training in electric vehicle repair and maintenance, Hong Kong will need to cultivate a significantly larger pool of skilled technicians to support the rapid uptake of commercial EVs. Targeted policies and initiatives to facilitate the seamless translation of skills from conventional to electric vehicles will be essential.

Furthermore, the establishment of a robust local battery disposal and repurposing market could provide alternative business models for small and medium enterprises, improve the overall utilisation of end-of-life batterie, and contribute to Hong Kong's sustainability objectives, rather than simply exporting used batteries overseas.

According to IDTechEx research, the global second-life EV battery market is expected to reach US$7 billion by 2033[146]. Second-life batteries refer to the reuse of EV batteries for stationary energy storage applications after they can no longer meet vehicle performance requirements. Second-life battery systems can offer a more cost-effective form of stationary energy storage compared to new battery packs, especially for applications like renewable energy integration, peak shaving, and backup power. The government could explore promoting and incentivising more developments of second-life battery technology and business models in Hong Kong to support the growth of this market.

Promoting innovation across the industry is critically important to enable investment in research and development for technological solutions that can address decarbonisation challenges and support future electrification uptake. For example, Singapore's Land Transport Authority (LTA) has launched a "sandbox" program that provides a controlled environment for companies and innovators to trial and test new transportation technologies. This allows the LTA to better understand the usage, benefits, and risks of these emerging technologies within the local context, before potentially updating regulations to accommodate them.

Developing this holistic ecosystem of technological workforce and circular economy capabilities is crucial to unlocking the true potential of commercial electric vehicle adoption in Hong Kong. Policymakers and industry stakeholders must work in tandem to address these multifaceted challenges and create an enabling environment that supports the transition to a sustainable commercial transportation future.

[146] IDTechEx forecasts second-life EV battery market to reach US$7B by 2033 - Green Car Congress

Case study: Germany invests in upskilling workforce for electric vehicle transition

Germany has recognised the critical importance of skilling and training its workforce as an essential component of its overall eMobility policies and initiatives. Keeping pace with the rapid transition to EVs, the German government has made significant investments in re-education and training programs to ensure its workforce is equipped with the necessary skills and expertise.

For 2023, the German government has budgeted €1.7 billion across multiple sectors to support and accelerate this upskilling effort. This substantial investment demonstrates the government's commitment to preparing its workforce for the demands of the evolving EV ecosystem, from manufacturing and maintenance to infrastructure deployment and service provision.

Key takeaways:

Hong Kong should ensure that the workforce keeps up with the EV transition, developing a cohesive ecosystem that can support the uptake of EVs

Source:
[EV industry can reshape employment landscape with green jobs, but building a skilled workforce]

Case study: Singapore "Sandbox" trials for new charging technologies

The Land Transport Authority (LTA) of Singapore has established a sandbox program to facilitate the development and use of new transportation technologies that are not yet covered by existing standards and regulations. The sandbox program provides a controlled environment for companies and innovators to trial and test their new technologies and allows LTA to better understand the usage, benefits and risks associated with these new technologies within the local context before potentially updating the regulatory framework to accommodate them.

Some examples of the sandbox trials include:

- Battery swapping services for electric HGV
- Mobile EV charging services to support the charging of electric vehicles

Key takeaways:

Hong Kong could consider Sandbox trials as it fosters a collaborative environment between the regulator and industry players, allowing for the smooth integration of new technologies into the land transport ecosystem.

Source:
[LTA | Land Transport Sandboxes]

Case study: Global efforts in EV battery recycling

Mainland China leads the world in battery recycling capacity, with over 500,000 metric tons of annual recycling capacity as of 2023. The country has implemented policies and regulations, including extended producer responsibility, to encourage battery recycling. Some companies in Mainland China have developed integrated systems such as CATL that cover the entire battery lifecycle, from production to recycling and materials recovery.

In the United States, the Inflation Reduction Act provides incentives for using recycled materials in new batteries, spurring investment in recycling. Companies are developing new processes, such as direct recycling, to make battery recycling more efficient and cost-effective. Automakers like Ford, GM and Stellantis are forming strategic partnerships with recycling companies such as Redwood Materials, Lithion Technologies, Cirba Solutions and Galloo. There is an increasing emphasis on creating closed-loop systems where materials from recycled batteries are used to produce new batteries.

Key takeaways:

The key factors contributing to EV battery recycling ecosystem include supportive government policies, industry collaboration, technological innovation and the development of economically viable business models.

Source:
[China's CATL to recycle EV batteries with Volvo Car]

Policy and regulation

Challenge: Lack of targets and industry alignment

Industry stakeholders are currently adopting a "wait and see" approach due to a lack of a clear roadmap and targets for what they need to do and by when. Commercial vessel operators are currently planning to replace vessels that are nearing or have reached end of life with new diesel-powered vessels, which will remain in operation for the next 25 to 30 years until they are retired from service. This opportunity lost means that these vessels will then continue to emit emissions and pollutants over a period where there was otherwise an opportunity to reduce or removed completely. This poses a significant risk to Hong Kong's 2050 ambition, especially where large or high-powered vessels are concerned.

Designing and constructing new vessels and deploying the required charging infrastructure is also a lengthy process, and optimistic estimates suggest that any action taken now to initiate design discussions with shipbuilders would not see those vessels commissioned and operational until 2027. This varies across different vessel types and sizes, but nonetheless highlights the implications of waiting.

"We are unsure of what new energy technology will be supported for local vessels, and we are hesitant to commit to any investments in electric vessels or charging facilities now in case the direction changes in the future"

- a local harbour fleet operator

Recommendation M1: Develop targets and roadmap

To provide clarity and confidence, the domestic maritime industry requires clear near, medium and long-term decarbonisation targets for local vessels. In setting realistically achievable targets, consideration of technology maturity across specific use cases will be crucial given the diversity of vessel types operating in Hong Kong. Fortunately, there are many global cases where electrification has been readily adopted as the technology of choice in similar ports to Hong Kong. The supply chain and underlying technology supporting the electrification of vessels is also rapidly advancing, meaning there are increasingly fewer vessel types for which electrification does not represent a viable option.

In addition to clear targets, a comprehensive roadmap is needed to support the industry's transition. This roadmap should address key challenges, including charging infrastructure development, access to capital financing, regulatory and process improvements, as well as incentives and support mechanisms that will be made available. A phased approach targeting "high-use" and "technologically ready" vessels could have the biggest impact on reducing carbon emissions within Hong Kong's harbour. Vessels like ferries that operate on regular schedules and 24/7 services such as tugboats and pilot boats tend to consume a lot of fuel, as well as pilot boats are all already operationally feasible, provided charging can be supplied. These types of high-use vessels stand to benefit the most from transitioning to electric propulsion in terms of emissions savings and reduced operational costs.

By defining targets and providing a detailed roadmap, the maritime industry will have the guidance and to invest with confidence. With that, operators will need to establish their own targets and plans in alignment with policy goals and ambitions to ensure the decarbonisation transition can be made in both a timely and cost-effective manner (with the cost component viewed from a lifecycle perspective). Operationally, some adjustments will also be required, which is why proper planning will be essential. There also exists an opportunity for inward investment into Hong Kong, in addressing the gap that exists around the charging infrastructure owner and operator space. This new area would facilitate the introduction of new technology and create jobs locally.

Case study: Singapore Maritime Decarbonisation Blueprint

The Maritime and Port Authority of Singapore developed the Maritime Decarbonisation Blueprint in 2022. The blueprint outlines ambitious, concrete long-term strategies to build a sustainable maritime industry and strengthen Singapore's position as a leading international maritime hub.

Importantly, it sets out clear and ambitious emissions reduction targets over the near and long-term - a 60% cut by 2030 and net zero by 2050. **It also establishes a definitive timeline for transitioning all domestic harbour craft to operate on zero-carbon energy solutions by 2030**. In terms of which energy solutions it recommends operators to adopt, the blueprint clearly identifies fully electric vessels as the long-term technology choice for domestic harbour craft.

Singapore's Maritime Decarbonisation Blueprint outlines several key actions to achieve its ambitious emissions reduction goals. These include transitioning all domestic harbour craft to low-carbon and eventually zero-carbon energy solutions by 2030, while adopting cleaner energy sources and automation in port terminals. The blueprint also emphasizes the development of infrastructure and standards for future marine fuels such as biofuels, methanol, ammonia and hydrogen, alongside incentives for the Singapore Registry of Ships to promote green vessels. Additionally, Singapore aims to establish itself as a global hub for maritime decarbonisation research and development, fostering collaboration with industry partners and committing significant funding to support these initiatives.

Key takeaways:

Several key areas could be applied to Hong Kong when setting maritime sector decarbonisation goals, including establishing clear emissions reduction targets, developing infrastructure and standards for future marine fuels, providing incentives and recognition for green ships, and investing in research and development.

Source:
Maritime Singapore Decarbonisation Blueprint

Recommendation M2: A central coordinating taskforce

Developing effective decarbonisation targets and roadmaps for the maritime industry requires strong coordination within the government and across industry stakeholders. Global best practices show that leaders in transport sector decarbonisation have set up a central coordinating body to align different government departments.

These coordinating bodies are typically in the form of an interdepartmental government task force or special working group. Crucially, these dedicated groups are given the authority to drive change, set bold and ambitious goals, align various agencies and departments on a shared vision and action plan, and hold relevant teams accountable. They will coordinate the implementation of policies, regulations, and incentives to support the industry's transition. The group should include members with expertise and industry knowledge in both land and marine transport in Hong Kong.

At the same time, industry organisations or collectives also have a role to play in coordinating group efforts around decarbonisation and are in some cases very well suited to the task. The Hong Kong Shipowners Association (HKSOA) for example, is one of the world's largest shipowner associations, and has existing ties to inter-governmental organisations that it can leverage to coordinate dissemination of relevant information and news pertaining to advancements in zero carbon technologies and fuels. For operators of harbour fleet vessels, there are opportunities to self-organise and leverage collective buying with power with OEMs for the purchase and installation of chargers or the procurement of vessels.

Case study: Examples of global central coordinating bodies

A new body is being established in Shanghai, China to oversee decarbonisation of shipping. **The Ministry of Transport in Mainland China is establishing the National Ship Energy Efficiency Management Centre**, tasked with overseeing industry decarbonisation efforts. This will include measuring and ensuring compliance of operators with emissions reporting requirements and administering penalties.

In Singapore, **the Maritime and Port Authority of Singapore (MPA) is the driving force behind the country's port and maritime development,** as well as a leading proponent of decarbonisation efforts in the sector. The MPA has taken a central role in developing the Singapore Maritime Decarbonisation Blueprint in close collaboration with industry stakeholders. This comprehensive blueprint serves as the guiding framework to chart the industry's transition towards a low-carbon future. MPA also plays a critical role in facilitating industry partnerships. For example, MPA has partnered with 3 private companies to pilot their vessel charging concepts for electric harbour craft (e-HC) in Singapore and has separately sought interest from financial institutions in providing government guaranteed green financing solutions to support transition of harbour craft vessels to zero-carbon technologies.

Key takeaways:
Hong Kong could establish an empowered Interdepartmental Maritime Decarbonisation Task Force to align government agencies, set ambitious targets and coordinate policies to support the industry's transition to low-carbon practices.

Source:
https://www.mpa.gov.sg/home
中华人民共和国交通运输部 - Ministry of Transport of the People's Republic of China (mot.gov.cn)
China launches Ship Energy Efficiency Centre in Shanghai

Operational feasibility

Challenge: Lack of awareness of available solutions and technology maturity

Local operators have expressed concerns about the technological maturity of fully electric vessels and the suitability of available solutions to meet their specific operational requirements. Tugboats, for example, need to be capable of very high-power output at low speeds over short (three to four hours) but intense operational periods. Pilot boats need to be capable of higher speeds (20 to 24knots) and longer ranges with relatively light loads (two crew members and two to four passengers). Ferries need to be capable of carrying up to 300 passengers in some cases, over relatively short distances at service speeds ranging from 14 to 20knots, but with much shorter turnaround times than the other vessel types mentioned. On the other hand, cross-border high-speed passenger ferries have a significantly higher speed requirement, typically operating at speeds of 40 to 50 knots.

"Electrification may not be suitable for us as our vessels need to operate at higher service speeds over longer ranges, and the time charter agreements have strict performance criteria, penalties and require uncertain hours of operation"

- local fast ferry operator

While some operators may consider "diesel-electric" vessels as a suitable option, this approach provides little benefit in terms of carbon reduction and still relies heavily on fossil fuels. To truly meet the desired long-term sustainability goals, a fully electric or zero-emission propulsion solution is needed.

Recommendation M3: Increase E-Vessel technology awareness

While regional case studies of fully electric vessels across all these use cases do exist, awareness of the latest developments globally and what is likely to work in Hong Kong from both a vessel performance and charging infrastructure perspective is limited. The reasons for this are twofold: there has been little incentive or push for commercial operators to transition harbour fleet vessels to zero carbon technologies and therefore no need for them to investigate or pursue options to decarbonise and electric vessel and charging technology is evolving so rapidly that it can be difficult to stay abreast of the available options.

Several actions can be taken to help bridge the awareness gap and facilitate closer collaboration between OEMs and vessel operators in Hong Kong. Industry summits and conferences provide an excellent platform for stakeholders to connect, share knowledge and exchange experiences. Globally, there are several relevant events, such as the Marintec[147] exhibition in Mainland China, the GreenPort Congress[148] to be hosted in France in 2024, and the Seawork[149] exhibition in the UK in 2024. More locally, the "Decarbonising Hong Kong Harbour with Norwegian Expertise" seminar[150] hosted by DNV in early 2024 was a successful reference event. Such events are invaluable in fostering dialogue and aligning efforts between shipyards and fleet operators to develop fit-for-purpose electric vessels and ultimately decarbonise.

In addition to in-person forums, innovative virtual platforms can also drive industry-wide collaboration. The "NextGEN - Green and Efficient Navigation" initiative, co-developed by the Maritime and Port Authority of Singapore and the IMO, is a virtual and digital ecosystem aimed at accelerating maritime transport decarbonisation through a collaborative global network.

147 Fair: Asia's Premier Maritime Fair | History, Exhibitors Shanghai (marintecchina.com)
148 GreenPort Congress & Cruise (portstrategy.com)
149 Seawork 2024
150 Decarbonising Hong Kong Harbour with Norwegian expertise - submit your interest (businessnorway.com)

Case study: Singapore Maritime Decarbonisation Asia Conference 2024 to drive technology awareness

In April 2024, Singapore hosted the Maritime Decarbonisation Asia Conference, attracting strong industry support and high-profile speakers from both public and private sectors, as well as international regulatory bodies. Key highlights included:

- Presentations by leading shipowners on decarbonisation strategies and energy-efficient solution criteria
- Insights into green financing trends and bank preferences
- Updates on methanol and ammonia supply chains and infrastructure
- Biofuel supply forecasts and pricing models

The conference enhanced awareness of maritime decarbonisation technologies and their practical applications, while addressing challenges and opportunities in the sector. It fostered collaboration towards a lower-carbon future.

Key takeaways:

Hong Kong can collaborate with international bodies and other maritime hubs to align decarbonisation efforts and share best practices. Additionally, Hong Kong can seek and integrate international expertise while developing its own strategies.

Source:
Maritime Decarbonisation Conference, Asia 2024

Challenge: Lack of local successful reference cases

The local maritime industry has not yet seen any electric vessels operating in Hong Kong's waters. This lack of real-world evidence in a local context has led to doubts about whether electric vessel technology will be viable and supported. Without proof that electric vessels can perform well in Hong Kong, the risks seem too high for many companies to embrace this emerging trend, despite global evidence to the contrary. Demonstrating the viability of electric vessels in the local context will be crucial to driving wider adoption in Hong Kong's maritime sector.

"We haven't seen electric boats in operation locally yet, and we are not sure if it will work in Hong Kong or not. We're waiting to see what the policy direction is before we commit to any investments in this area"

- local harbour fleet operator

Recommendation M4: Create local successful reference cases

Local reference cases can help build market confidence to invest in harbour fleet electrification. The government's own vessel fleet represents a valuable opportunity to demonstrate the feasibility of electrification to industry. By transitioning the government's and industry's fleet to electric, it can showcase the technology's viability and encourage private operators to follow suit.

The government's recent HK$350 million injection to subsidise electric ferry trials and charging facility development by four in-harbour ferry operators is a positive step in showcasing to industry what is possible.

Globally, there are also reference cases of electrification across almost every harbour fleet vessel segment and, as mentioned above, organised sharing of information regarding the latest developments will help spread awareness and encourage adoption of these latest technologies in Hong Kong. With some independent research however, local industry can also quickly gain an understanding of what electric vessel technologies are available, and collaborations between vessel owner/operators, OEMs and end customers to trial, prove and adopt such technologies.

Fully electric tugboat in Ports of Auckland. (Source: Damen Shipyard)

Charging of e-ferry in Norway

Shore power at the Port of Oslo

Sightseeing e-ferry in Wuhan China

Floating battery for charging in Amsterdam (Source: Purus)

Case study: Norway's electrification initiatives in the maritime sector

Norway has taken significant steps to electrify its maritime sector, including government-operated vessels. Here are some key initiatives:

1. **Electric ferries:** Norway has introduced several electric ferries into its fleet, including the world's first all-electric car ferry, "Ampere," which began operations in 2015. This ferry operates on the Sognefjord and has significantly reduced emissions compared to traditional diesel-powered ferries.
2. **Zero-emission vessels:** The Norwegian government has committed to having all new car ferries operating on national routes to be zero-emission by 2025. This ambitious goal is part of Norway's broader strategy to reduce greenhouse gas emissions from the maritime sector.
3. **Public sector leadership:** The Norwegian Public Roads Administration has been a key player in promoting the use of electric ferries. By setting strict environmental requirements in their procurement processes, they have driven the adoption of electric and hybrid ferries.

Key takeaways:

1. Government leading by example with strict environmental standards and procurement policies
2. Pilot projects to demonstrate feasibility and gain experience with electric marine technology
3. Investment in charging infrastructure, including shoreside power and fast-charging
4. Collaboration with industry, research, and international experts for innovative local solutions
5. Regulations and incentives, such as subsidies and preferential port treatment, to encourage adoption

Source:
Norway showcases award-winning electric ferry technology
Norway's "ferrytale" on green waves

Charging Infrastructure

Challenge: Underdeveloped infrastructure

Charging infrastructure requirements vary as much as vessel types and operational profiles do. Most commercial operators will require their own dedicated chargers, especially where frequent use, short turnaround times or time charter agreements with specific performance criteria necessitate it.

> *"Our operations run 24/7 and require minimal downtime for charging. However, without reliable access to charging facilities, we are unable to ensure the continuous, uninterrupted operations that are essential for our business"*
>
> *- local harbour fleet operator*

Complicating matters is the lack of available land, high capital costs and complex approval processes that involve multiple involvement of stakeholders such as various government departments, industry partners etc. At present multiple departments may need to be involved in the approval and installation of appropriate charging infrastructure, and industry stakeholders may not have a good idea of what the approval process would involve or require from them.

Shared charging in Singapore (Source: Incat Crowther)

Recommendation M5: Infrastructure planning and coordination

To address the challenge of the complex and drawn-out approvals for installing charging facilities, a well-defined and streamlined process for obtaining relevant approvals and installing charging infrastructure will be crucial. This could involve establishing a one-stop-shop permitting process involving relevant regulatory departments and improving stakeholder engagement and communication. Considering the numerous ongoing reconstruction and land redevelopment projects across Hong Kong, the central coordinating taskforce would collaborate with other government departments to identify opportunities to allocate suitable public lands, particularly around piers, for the development of such infrastructure.

These measures would provide maritime operators with clarity and confidence to move forward, while also removing friction that might impact the overall uptake of electric vessels.

In parallel a well-coordinated and strategic plan for the deployment of charging infrastructure will also be vital to support the widespread adoption of electric vessels in Hong Kong's maritime sector. This should involve a mix of industry stakeholders with support and guidance from utilities to ensure the unique requirements of different operators are considered. Through discussions with stakeholders, the report has identified several strategic locations to deploy shared charging infrastructure, which represent mutually convenient locations for various fleet operators. The idea would be that deployment of the infrastructure is managed in coordination with a small group of operators, initially for their dedicated use, to ensure operations are not impacted by availability issues that might arise if the infrastructure was immediately shared more broadly.

Case study: Amsterdam provided shared charging infrastructure for electric pleasure crafts

The city of Amsterdam has implemented an emission-free zone for boats and ships operating within its urban waterways. This policy is part of Amsterdam's broader efforts to transition towards more sustainable transportation and improve air quality.

Key initiatives:

- Amsterdam has banned the use of diesel-powered ships and boats within the city centre starting in 2025, which will affect no fewer than 10,000 boats.
- The city is providing incentives and subsidies to encourage the adoption of electric and zero-emission vessels.
- Regulations are in place to gradually tighten emission standards for boats and ships operating in the city's waterways.

Public charging infrastructure:

To support the transition to emission-free water transport, Amsterdam is investing in a network of public charging stations for electric boats and ships along the city's canals and waterways:

- There are currently around 15 charging stations in Amsterdam, with plans for further expansion.
- These charging stations allow boat owners and operators to easily recharge their electric vessels, facilitating the shift to zero-emission water transport.

Key takeaways:

Amsterdam's comprehensive approach, including the investment in public charging infrastructure, demonstrates the city's strong commitment to creating a more sustainable and environmentally friendly water transportation system. Hong Kong can learn from this model as it looks to develop shared charging infrastructure to fit for the electrification needs.

Source:
Smart charging solutions for recreational (private) boats | Startup in Residence City of Amsterdam
2025: Total ban on thermal boats in Amsterdam - Yachting Art Magazine

Economic consideration

Challenge: Supply and demand mismatch in shore power

The global maritime industry is seeing more ocean-going vessels become equipped to use shore power while docked. However, Hong Kong's local terminals have not yet experienced high demand from vessel operators for shore power services. As a result, the terminals have shown less enthusiasm for developing similar shore power capabilities, even as these technologies are being adopted globally.

"We do not see subsidies made available as we see in other markets to support shore power investment"

- local shipping terminal operator

This lack of shore power infrastructure development in Hong Kong's ports could put the city's future competitiveness as an international shipping hub at risk. As more vessels become shore power-ready and environmental regulations tighten worldwide, the absence of shore power capabilities in Hong Kong may become a disadvantage.

Recommendation: M6: Financial support for shore power development and mandates on use by ships

Given the global upward trend in shore power-ready ocean-going vessels, accelerated investment in shore power infrastructure has the potential to enhance economic activity and protect Hong Kong's position as a leading global shipping hub. As demand for shore power increases due to EU ETS penalties, FuelEU Maritime regulation on well-to-wake GHG emission and IMO emissions targets influencing shipping companies' port selection decisions, maintaining pace with other international maritime centres is crucial for Hong Kong's long-term competitiveness.

Implementing shore power infrastructure is a complex and capital-intensive endeavour, often posing significant challenges that impede widespread adoption. To overcome this barrier, terminal operators in Hong Kong require clear guidance and robust financial support to effectively deploy the necessary shore power facilities. This will not only future-proof Hong Kong's port and shipping industry and align with international trends in the cruise industry but also deliver meaningful environmental benefits through reduced vessel emissions while berthed. At the same time, following the lead of other countries and jurisdictions, mandates that compatible vessels utilise shore power while at berth will help make the facilities more operationally viable for terminals.

Industry can also take proactive steps to plan for future demand, noting the anticipated implications of EU ETS penalties, Fuel EU regulations and IMO targets for shipowners. At present, there are market examples of terminal operators using container batteries to meet shore power needs. The advantage being that batteries can be charged during off-peak times and discharged during peak periods to maximise potential revenues from shore power. Where terminal operators also invest in electrification of shoreside plant and equipment, the batteries can serve a dual purpose and potentially help to realise additional cost savings.

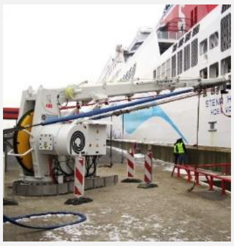
Case Study: Global Government Support for Shore Power

By 2022, **81% of OPS berths at Mainland China's 21 coastal ports** were equipped with OPS, including all such berths at the country's seven biggest ports. The 14th Five-Year Plan (2021-2025) sets a target of 100% shore power coverage for cruise ship terminals by 2024 and aims to achieve 90% shore power coverage for key container ship terminals by the end of 2025. The focus has now shifted to increasing the utilisation of OPS.

The **Netherlands**' "Temporary Subsidy Scheme Shore Power Marine Vessels Climate 2024-2026" allocates a total fund of €170 million to provide subsidies covering up to 45% of eligible costs for constructing shore power facilities in seaports.

Norway's Enova, a government enterprise, allocated NOK143 million (approximately US$13.6 million) to support seventeen shore power projects. This targeted investment demonstrates a government's commitment to fostering a shift towards shore power use.

Shore power in Norway



Shore power in Rotterdam Netherlands

In **US**, the Environmental Protection Agency (EPA) provides grants for shore power projects through its Diesel Emissions Reduction Act (DERA) program. Some states, like California, have additional funding programs for shore power installations. For example, the remediation fund under the Ocean-Going Vessel At-Berth Regulation provides a compliance pathway for regulated vessels who are unable to use shore power during a vessel visit, allowing them to pay into a fund that will support emissions reduction projects in impacted communities.

The EU has set targets for shore power availability in major ports by 2025 as part of its Alternative Fuels Infrastructure Regulation. Under the Fit for 55 Programme, containerships and passenger ships at major EU ports will be obliged to use on-shore power supply as of 2030. EU provides funding through programs like the Connecting Europe Facility (CEF) for Transport.

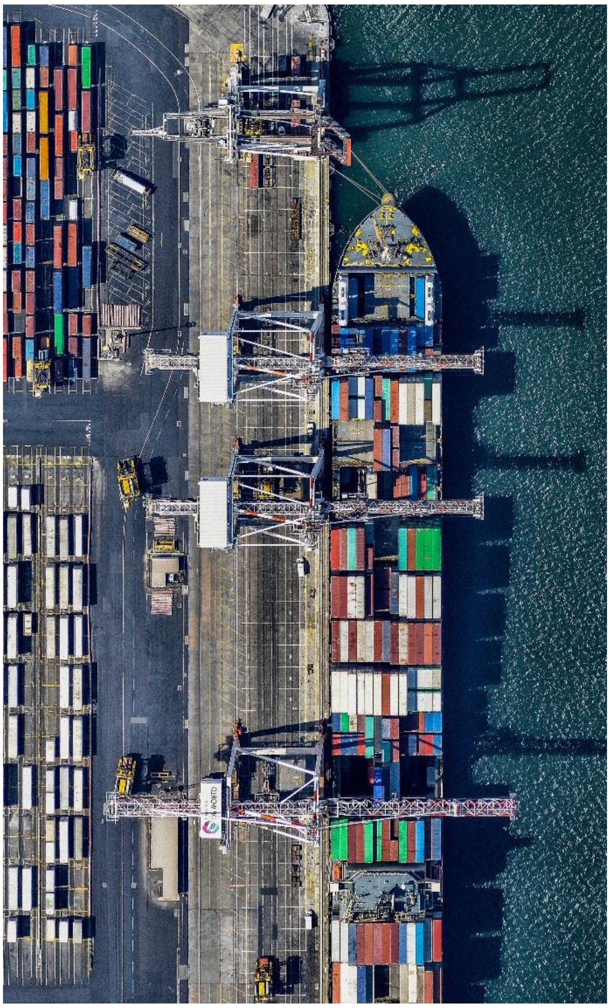
Key takeaways:

Government support for shore power initiatives globally reflects a growing commitment to reducing emissions from maritime activities. A long-term strategy for shore power that considers future shipping trends and technologies could be considered, ensuring that the port remains competitive and environmentally responsible. By collaborating with neighbouring ports in the Pearl River Delta to create a regional shore power network, enhancing overall effectiveness.

Source:
China's significant investment in shore power infrastructure
Temporary Grant Scheme on Shore Power for Seagoing Ships 2024-2026
17 shore power projects get $13.6M from Enova
Diesel Emissions Reduction Act (DERA) Funding
Ocean-Going Vessels At Berth Regulation | California Air Resources Board
Fit for 55: deal on new EU rules for cleaner maritime fuels

Challenge: High capital cost of vessels, chargers and OPS infrastructure

Acquisition of vessels: The electrification transition in Hong Kong's maritime sector faces a critical barrier in the form of high upfront costs. The construction or acquisition of an electric Class I or Class II vessel can cost 30-40% more than a conventional counterpart. While the lower total cost of ownership over most vessel's lifespans (due to reduced maintenance and especially reduced fuel costs) makes electric technologies an economically viable option, the substantial initial capital investments required presents a significant challenge for fleet operators. Compounding this financial hurdle is the lengthy new vessel development process, which discourages fleet owners from committing resources to electrified vessels without the assurance that charging facilities will be made available and that long term policy views and support are in place, as noted in previous sections.



"Electric vessel and chargers are expensive. And who will bear the cost for charging infrastructure?"- local harbour fleet operator

"It is not an advantage to be a first mover, as the financial and operational risk is still high"

– electric ferry investor and operator

Onshore Power Supply: The high capital costs involved are also a major obstacle to the development of shore power infrastructure in Hong Kong. The upfront investment required for these projects is substantial, and this challenge has been made worse by the recent decline in cargo throughput at Hong Kong Port. Without a proven long-term financial upside and adequate financial support, industry players in Hong Kong remain reluctant to proactively invest in shore power and other alternative fuel bunkering solutions, even as these technologies are gaining traction globally.

Recommendation M7: Targeted levers and incentives in the maritime sector

Given the high upfront costs and lingering market uncertainties, government support will be crucial to support the necessary infrastructure development. The capital expenditure required for charging facilities, grid upgrades and related infrastructure represents a significant barrier for individual market players. Coordinated planning, public and private funding will be essential to enable the effective and widespread deployment of this charging ecosystem.

In terms of vessel electrification, providing support targeted at "high use" vessels with high fuel consumption will likely have the biggest impact on carbon emission reductions within the Hong Kong harbour. These vessels, such as ferries and tugboats that operate with intensive schedules, stand to gain the most from transitioning to electric propulsion in terms of emissions savings. These environmental benefits can be maximised and catalyse wider adoption of the new technology across the maritime sector.

"We have invested in shore power infrastructure in other regions with support from the local governments. However, as the current economic environment is quite tough in Hong Kong, it is difficult for us to invest without additional financial help."

– international terminal operator

Case study: Global investment and support for maritime electrification

Governments around the world are taking decisive steps to accelerate the electrification of maritime transportation. Several countries have launched significant funding initiatives to support the development and deployment of electric ferries and vessels.

- The **New Zealand** government has provided NZD27 million to fund the construction of fully electric ferries in Auckland, building on the success of a pilot project in Wellington.
- In **Norway**, Enova, a government enterprise, has offered funding worth more than NOK700 million for several projects to decarbonise shipping, including two initiatives for all-electric vessels.
- The government of **British Columbia, Canada,** has allocated CA$500 million to BC Ferries for the electrification of their marine vessels.

Key takeaways:

These initiatives demonstrate a growing global commitment to transitioning maritime transportation towards zero-emission solutions, leveraging public funding to drive sustainable innovation and infrastructure development in the shipping industry.

Source:
Electric Ferries for Auckland – Greater Auckland
Enova pumps $65.6 million into zero-emission ship and tech projects - Offshore Energy (offshore-energy.biz)
New funding will keep ferry fares affordable | BC Gov News

Recommendation M8: Facilitating access to capital for the maritime sector

Apart from direct public funding and subsidies, a well-developed private financing network would provide convenient access to the capital needs of different maritime sectors. As a global financial hub, Hong Kong has a wealth of financial institutions offering various financing options. However, due to the fragmented nature of the maritime industry and the relative newness of vessel electrification technology, many maritime operators, especially smaller players, may not have full access to the required capital in the market for future electrification efforts.

A coordinated approach connecting the private financing community with the maritime industry will be critical. It is important to encourage financial institutions to identify the unique characteristics of the Hong Kong maritime market and develop tailored financing structures adapted to these specific features.

To further incentivise this private-public collaboration, the government may consider backing some of the financial risk through loan guarantees, co-investment schemes or other risk-sharing mechanisms. This would help de-risk these investments for the private sector and attract greater capital flows into the maritime electrification ecosystem. By leveraging both public and private funding sources, the transition to a sustainable, electrified harbour fleet can be accelerated. Introducing carbon trade system to diversify incentive options could also be considered.

Case study: Singapore's initiatives to unlock financing for harbour craft electrification

The Maritime and Port Authority of Singapore launched an Expression of Interest (EOI) in 2023, inviting financial institutions, intermediaries, marine insurance providers, and brokers to submit proposals aimed at accelerating the adoption of electric harbour craft in Singapore.

In April 2024, MPA shortlisted 5 banks to structure innovative financing options tailored for harbour craft owners. This initiative is designed to improve capital accessibility for operators, supporting Singapore's goal that from 2030, all new harbour craft operating in the Port of Singapore must be fully electric or use other net-zero fuels.

Key takeaways:

Facilitating access to adequate financing for smaller maritime players by lining up qualified financial institutions and providing risk-sharing support to help address the challenges in this fragmented industry.

Source:
Financiers and Insurers Ready to Support Electrification of the Domestic Harbour Craft Sector | Maritime and Port Authority of Singapore (mpa.gov.sg)

Recommendation M9: Deliver at scale through public-private partnerships

Public-private partnerships can be a critical enabler for the transition towards zero-emission transportation technologies. By bringing together private companies, organisations and government ministries, these programs can generate knowledge and facilitate collaboration. Most importantly, they can help address the high capital cost challenges faced by the industry by working together to develop feasible solutions.

The Green Shipping Programme (GSP) in Norway provides a valuable example. Initiated in 2015, the GSP engages Norway's entire shipping cluster, including government agencies, shipping companies, technology providers, research institutions and industry organisations. The main goal is to facilitate the implementation of green technologies and solutions to reduce emissions from coastal shipping in Norway.

Through such public-private partnerships, governments and industry players can leverage their collective expertise and resources to drive the transition to a decarbonised transport sector.

Case study: Public-private partnership in Norway to drive maritime decarbonisation

The Green Shipping Programme (GSP) is a public-private partnership established in 2015 to advance Norway's goal of creating the world's most efficient and environmentally friendly shipping industry. The program brings together private companies, organisations and government ministries to generate knowledge, start pilots, exchange knowledge, scale up pilots and facilitate dialogue and collaboration. The program's key goals are to achieve cost-effective emissions reductions, economic growth, sustainable logistics solutions, increased competitiveness and new jobs in the shipping industry.

Some key achievements:

- Electrification of ferries and shipping: The program's early work on assessing the potential for battery and gas-powered maritime transport in Norway contributed greatly to the "ferry revolution" – the electrification of Norway's ferry fleet, which grew from 15 to 450 battery-powered ships in five years, with Norway achieving a 40% market share.
- Influencing national strategies: The program has provided evidence-based input to guide the Norwegian Government's strategy for green competitiveness, with a focus on developing green framework conditions and early markets for green technologies.
- Scaling green solutions: In later phases, the program increased its scope to pilot more green logistics solutions, technologies, fuels and financial models, aiming to provide a testbed for scaling up successful green innovations.

Key takeaways:

The public-private partnership model is instrumental in accelerating green transport development. By bringing together industry players, government and research, the program has been able to identify barriers and opportunities, pilot and demonstrate innovative green solutions with real-world testing and influence policy and regulatory frameworks to create favourable conditions for scaling up green technologies.

Source:
The world's most efficient and environmentally friendly shipping – Green Shipping Programme

Case study: Shore power launch at Port Miami through industry partnership

Through an industry partnership between Miami-Dade County, Florida Power & Light Company and several cruise lines including Carnival Corporation, the world's largest cruise company, Port Miami is now the first major cruise port on the US eastern seaboard offering shore power connections at five cruise berths.

The shore power capability allows Carnival's cruise ships to use electrical power from the local grid while docked, reducing emissions and noise levels. This partnership between Carnival and the Port of Miami is a prime example of how industry cooperation can drive positive environmental change. By working together, the two organisations have been able to exceed industry benchmarks and set a new standard for sustainable cruise operations.

The launch of shore power at Port Miami is part of Carnival's broader strategy to invest in technologies and initiatives that reduce the company's environmental footprint. This collaborative effort showcases the benefits of industry partnerships in addressing pressing environmental challenges and paving the way for a more sustainable future in the cruise industry.

Key takeaways:

Fostering similar partnerships between the government, utility companies and terminals, could enable Hong Kong to accelerate the adoption of shore power and other green technologies.

Source:
PortMiami: Shore Power Ready - Cruise Industry News | Cruise News

Other considerations

Recommendation M10: Targeted initiatives to support wider ecosystem

To enable the widespread adoption of marine electric vessels and shore power in Hong Kong, a well-developed supporting ecosystem is crucial, mirroring the challenges faced in land transport electrification. This includes ensuring a skilled workforce capable of servicing and maintaining these advanced technologies, as well as establishing a robust local battery disposal and repurposing market.

The current labour pool, predominantly comprising diesel-based marine engine operators, may lack the necessary expertise to effectively maintain the complex electric powertrains and associated systems required for zero-emission maritime solutions. Targeted training and professional development programs, in collaboration with OEMs and industry stakeholders will be crucial to equip the existing workforce with the skills and knowledge to support the operation and upkeep of electric vessels and shore power infrastructure.

Furthermore, the establishment of a local battery disposal and repurposing market could provide alternative business models for small and medium enterprises, improve the overall utilisation of end-of-life batteries, and contribute to Hong Kong's sustainability objectives, rather than simply exporting used batteries overseas. This would mirror the importance of a robust battery recycling ecosystem in the land transport electrification context.

Conclusion

Through this study, EY teams have identified a range of challenges for electrification and decarbonisation across the transport sector. However, there are also some positive successful cases that serve as examples:

- A local retail truck fleet operator has successfully piloted a fleet of 5.5-tonne electric trucks, realising immediate benefits in terms of operating expense savings as well as operational improvements by powering their temperature-controlled storage while stopped.
- A global logistics operator is leading the decarbonisation journey by electrifying part of their fleet and has a commitment to further electrify in alignment with their corporate global targets.
- Multiple local fleet operators have expressed keen interest in electrifying their fleet, proactively exploring the feasibility and technology pathways and is ready to electrify once the broader targets and roadmap are in place.

While most stakeholders are still facing various challenges that are preventing them from taking action on electrification and decarbonisation, the successful case studies identified in this study serve to excite and provide inspiration across the wider industry community.

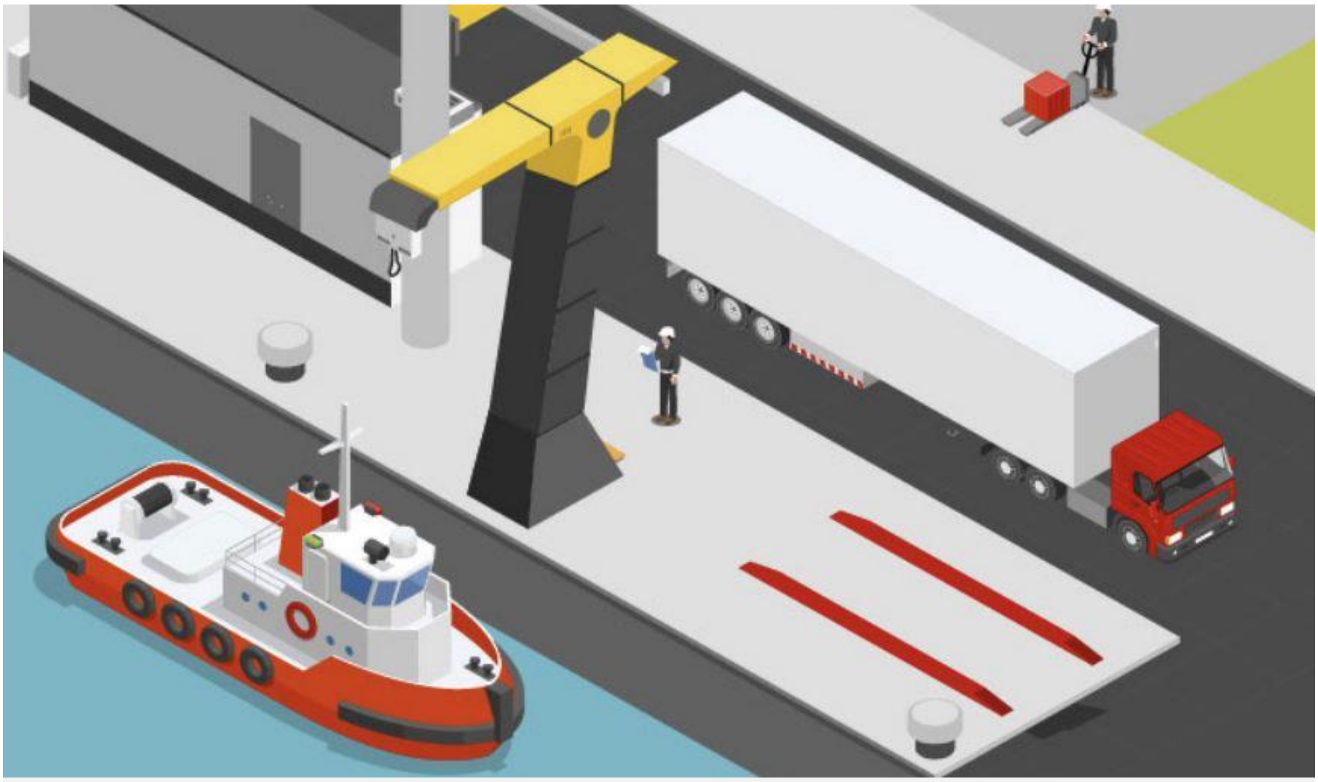
One key observation is that the challenges faced by other stakeholders are largely similar between land and marine transport. Common themes include the need for clearer policy direction, further financial support, industry collaboration and the development of robust charging infrastructure.

Interestingly, some global industry players have already recognised the potential synergies between land and marine transport electrification and have started developing integrated solutions that can accommodate the charging requirements of both electric vessels and commercial vehicles. This approach helps to improve the utilisation of the charging infrastructure and creates a stronger business case for investment.

Given the diverse and complex nature of the transport ecosystem, implementing these solutions across both sectors will require a holistic approach and a high level of coordination and planning.

Effectively addressing these challenges requires a comprehensive framework and blueprint that outlines the priorities, as well as the roles and responsibilities of each ecosystem player. In the following section, we will present a high-level framework for this to help drive the transition.

This framework will provide a structured approach to tackling the multifaceted challenges in the transport sector's electrification and decarbonisation efforts. By outlining the priorities and aligning the responsibilities of various stakeholders, it will help ensure a cohesive and effective implementation of the identified solutions.



Truck and ship charging illustration.

Case study: Global oil & gas player's MegaWatt charger for electric trucks and ships

A prominent Global oil & gas player has developed and commissioned the first MegaWatt charger capable of charging both electric trucks and electric ships. This charger, installed at the Energy Transition Campus Amsterdam (ETCA), has a capacity equivalent to three regular 350kW fast chargers typically used for trucks.

The key synergy is that this single charging system can accommodate the high-power needs of both heavy land-based vehicles like trucks and buses, as well as maritime vessels. By using a universal charging interface with adapters for different vehicle types, the MegaWatt charger creates an integrated charging solution that can serve the electrification requirements of both the land and marine transport sectors.

This shared charging infrastructure approach helps to improve utilisation and create a stronger business case for investment. It also represents an innovative way to overcome the common challenge of developing robust charging networks to enable the widespread adoption of electrification in both the land-based and maritime domains.

Key takeaways:

By leveraging shared charging capabilities across land and marine applications, transport operators can potentially achieve greater economies of scale and optimise infrastructure costs. This type of cross-sector collaboration represents an innovative way to overcome the infrastructure deployment challenges. When seeking solutions to address decarbonisation challenges in Hong Kong, industry players should look for potential synergies between land and marine applications.

Source:
Oil & Gas player launched the first MegaWatt charger for trucks & ships in the Netherlands in collaboration with EST-Floattech – Maritime Battery Forum

4. The Blueprint to accelerated and efficient transition to eMobility

Given the complexity and importance of the transition to eMobility, overcoming the barriers outlined in prior sections will require a collaborative effort across all ecosystem stakeholders. The recommendations provided in the previous section draw on insights from global case studies and best practices adapting them to Hong Kong's local context and combined with local industry stakeholder insights and expertise.

At the core of these recommendations is the need for better market coordination among industry participants, government, utility providers and academia. While policy coordination and support are crucial to the success of transport decarbonisation in Hong Kong, there are also actions that market players such as utilities, fleet operators, OEMs and others can and should take in parallel to accelerate the pace of change.

Below, we set out the sequence for the enablement of the decarbonisation transition of commercial land and marine transport. The actions described herein correspond to the recommendations provided in Section 3 and have been numbered accordingly. For more detail on what each recommendation entails, please refer back to that section.

We sequence the recommendations and initiatives in the following phases.

Align 2024	Organise & Plan 1H 2025	Collaborate & Lead 2H 2025	Invest & Scale 2026 - 2030	Sustain 2030+
With multiple ongoing studies, reports and roadmaps being developed concurrently by both industry and the Hong Kong Government, it is critical to take a holistic view, **align and reconcile** the various perspectives on how the city can move forward in its transition to green transportation. Consolidating and aligning on various roadmaps, would enable stakeholders to **synchronise** and move forward with clarity regarding what needs to be considered in the development of future plan.	The effective transition of commercial land and marine transport requires **a high level of coordination** within Government and across the landscape of diverse stakeholders and **ecosystem players.** It's important to consider how this will be led and by whom. Government and industry players have a role to play, and while **self-organisation** is possible, it is unlikely to drive the level of change required. Therefore it will be critical to provide clear policy direction and targets to the market, with a roadmap towards implementation.	With a clear target, roadmap and plan in place, the next step is to **lead by example in transport electrification** (e.g. running trials demonstration feasibility of electrification). This would demonstrate the commitment to sustainability, increase market confidence, encourage OEM interest in the Hong Kong market, support the deployment of charging infrastructure and offer valuable lessons learned for the industry.	As the transition towards green transportation shifts from a technological to a financial challenge, investing time and capital is crucial for a **scaled transition** that provides tangible decarbonisation benefits to Hong Kong residents. With finite resources available, **a phased approach** is critical, targeting segments most ready for electrification, such as LGVs for land and commercial ferries and work vessels for marine, where the return on investment and operational benefits can be more readily realised. Meanwhile, **continuous planning**, testing, and piloting for new technologies for harder to abate segments shall continue.	To effectively transition at the pace and scale required to meet Hong Kong's and national decarbonisation targets by 2050, **continued development** of Hong Kong's eMobility ecosystem is crucial, with many recommendations and activities discussed in this report **extending beyond this decade**, such as infrastructure development for additional charging stations or shore power. While this report provides initial recommendations to accelerate Hong Kong's journey, it is equally important to emphasise the need **for consistent implementation** by Hong Kong stakeholders, buying-in to a **new era of transportation** within the city beyond this decade, thus sustaining a change that **benefits all citizens and visitors** of this bustling metropolitan.

Note: Timelines per EY Analysis

Hong Kong Transport Decarbonisation Blueprint (Land)

Challenges	Align (2024)	Organise & Plan (1H 2025)	Collaborate & Lead (2H 2025)	Invest & Scale (2026-2030)	Sustain (2030+)
Policy & Regulation	Align on various roadmaps & perspectives	L2 Establish a central coordinating task force	L3: Review & streamline EV regulations and policies		
		L1 Develop segment level targets and roadmap for near, medium, long term			
Operational Feasibility	L4: Optimise processes to reduce time-to-market for EV OEMs				
		L5: Foster industry partnerships to expand availability of suitable EV models in Hong Kong			
		L6: Prioritise corporate, quasi- and govt fleet electrification			
			L7: Launch pilot programmes such as "try before you buy"		
Infrastructure Development		L8a: Identify public charging hub strategic locations	L8b: Rollout and build public charging hubs in strategic locations		
			L8c: Develop commercial vehicles charging subsidy scheme and cost sharing framework		
		L9a: Prioritise standards & data interoperability requirements	L9b: Develop standards to support data exchange		
		L10a: Assess grid impact & risks	L10b: Collaborate on grid-city-transport planning	L10c: Invest strategically in network upgrades/grid capacity	
			L10d: Implement ToU and other smart charging solutions at scale		
Economic Considerations			L11a: Targeted levers to electrify LGVs & Buses		
				L11b: Targeted levers to electrify MGVs & HGVs	
			L12: Foster innovative business models through industry collaboration		
Other				L13: Targeted initiatives to support wider EV ecosystem	

Note: Timelines per EY Analysis

Hong Kong Transport Decarbonisation Blueprint (Marine)

Challenges	Align	Organise & Plan	Collaborate & Lead	Invest & Scale	Sustain
	2024	1H 2025	2H 2025	2026-2030	2030+

Policy & Regulation
- Align on various roadmaps & perspectives
- **M1**: Develop segment level targets and roadmap for near, medium, long term
- **M2**: Establish a central coordinating task force

Operational Feasibility
- **M3**: Design and run e-vessel technology awareness campaigns (incl. virtual knowledge sharing platforms)
- **M4a**: Plan and fund other trials, demonstrating feasibility of electrification via pilot projects
- **M4b:** Create local successful reference cases via investments

Infrastructure Development
- **M5a**: Streamline and establish clear guidelines on implementation requirements and process
- **M5b:** Develop holistic plan for charging infrastructure, incl. strategic locations
- **M5c**: Deploy shared charging infrastructure in strategic locations
- **M5d**: Deploy territory-wide charging infrastructure
- **M6**: Clear direction and financial support for OPS infrastructure and mandate its use

Economic Considerations
- **M7**: Develop support mechanisms for vessels and chargers
- **M8**: Facilitate access to capital for the Maritime sector
- **M9**: Deliver at scale through Public-Private-Partnerships

Other
- **M10:** Targeted initiatives to support wider ecosystem

Note: Timelines per EY Analysis

Conclusion

The global drive to combat climate change has reached unprecedented levels, with significant focus on reducing emissions from the transport sector, which contributes approximately 20% of global greenhouse gas emissions. The city's exposure to extreme weather events and its need to maintain competitive port operations underscore the urgency of decarbonising transport. Failure to act decisively could result in economic losses, degraded air quality, and missed opportunities in the global push towards sustainability and the city's journey to realising its vision in becoming "3 centres 1 hub'.

Despite significant growth in the sale of EVs among individual buyers in recent years due to the ban of ICE passenger vehicles sales by 2035 and the government mandated use of low-sulphur fuels by ocean going vessels while operating with the Port limits, there is still much more to accomplish and market players in Hong Kong, across both land and marine, are yet to make significant investments in decarbonisation.

Delivering a world-class eMobility ecosystem is a highly complex undertaking and this report, in conjunction with eMobility industry stakeholders have identified challenges and pragmatic recommendations that should be considered.

Global experiences clearly show that this cannot be achieved by governments in isolation, or by independent activities in an open market. It requires strong leadership, coordination and collaboration from both governments, utilities and key industry players with skills and capabilities to deliver at scale.

With broad assertive and collaborative action in the next few years, Hong Kong could see tremendous success in the electrification of its commercial vehicle and maritime sector and become a leading case study for how to enable a world-class eMobility ecosystem. More importantly, it could accelerate benefits for Hong Kong as a clean, healthy, modern and smart metropolis that all its citizens will be proud of.

Summary of Terms Used in the Report

Acronyms	Definition
AFIR	The Alternative Fuel Infrastructure Regulation
Baas	Battery-as- a-Service
BEV	Battery Electric Vehicle
CAP 2050	Climate Action Plan 2050
CAPEX	Capital Expenses
CCS	Combined Charging System
CEF	Connecting Europe Facility
CLIA	The Cruise Lines International Association
CNG	Compressed Natural Gas
CO2	Carbon Dioxide
COP28	United Nation’s 2023 Climate Change Conference
COP28	Carbon Monoxide
DERC	Diesel Emissions Reduction Act
DNOs	Distribution Network Operators
DSOs	Distribution System Operators
EHSS	EV-charging at Home Subsidy Scheme in HK
eMobility	The concept of using electric powertrain technologies, in-vehicle information, and communication technologies and connected infrastructures to enable the electric propulsion of vehicles and fleets
EOI	Expression of Interest
EPA	Environmental Protection Agency in US
EPBD	The Energy Performance of Buildings Directive
EPD	Environment Protection Department in HK
e-PLBs	Electric Public Light Buses
ESG	Environmental, social and governance

ETCA	Energy Transition Campus Amsterdam
ETS	Emissions Trading System in EU
EU	European Union
EV	Electric Vehicle
EY MCI Index	EY Mobility Consumer Index
FCEV	Hydrogen Fuel Cell Electric Vehicle
GB	GuoBiao
GBA	Greater Bay Area
GCSP	The Green Coastal Shipping Programme
GHG	Greenhouse gas
GSP	The Green Shipping Programme
HDV	Heavy-duty vehicle
HFO+	Heavy Fuel Oil Plus
HGVs	Heavy goods vehicles
HKSOA	The Hong Kong Shipowners Association
HVO	Hydrotreated Vegetable Oil
ICCT	International Council on Clean Transportation
ICE	Internal combustion engine
IEA	International Energy Agency
IMO	International Marine Organisation
IRC	Internal Revenue Code
LGVs	Light Goods Vehicles
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSFO	Low Sulphur Fuel Oil
LTA	Land Transportation Authority in Singapore

MCS	Megawatt Charging
MGVs	Medium Goods Vehicles
MPA	The Maritime and Port Authority of Singapore
NET	New Energy Transport
NM	Nautical Miles
NOx	Nitrogen Oxide
OEM	Original Equipment Manufacture
OPEX	Operating Expenses
OPS	Onshore Power Supply
PHEV	Plug-In Hybrid Electric Vehicle
PTIs	Public Transport Interchanges
R&D	Research & Development
RED	The Renewable Energy Directive
Taas	Truck-as- a-Service
TCO	Total Cost of Ownership
TOU	Time-of-use
UK	United Kingdom
UN	United Nation
UNCTAD	UN Trade and Development
US	United States
V2G	Vehicle-to-Grid
VAT	Value Added Tax
VOC	Volatile Organic Compounds
VSS	Vessel Subsidy Scheme In HK
VTC	Vocational and Technical Colleges
WCS	Workplace Charging Scheme

WHO	World Health Organisation

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