ARUP

10 thoughts for the future of low-emission mobility

Around the world, advances in technology combined with the drive to improve air quality and lower carbon emissions are leading to disruptive change in the movement of passengers and freight. There is also a strong desire to ‘come back better’ as we recover from the COVID-19 crisis that has swept many countries around the globe.

The move to a low-emission vehicle future will require new thinking and infrastructure, from innovative policies to support uptake to new charging infrastructure and network upgrades. The decisions we make today need to be future proofed against the most likely of these trends, avoiding the risk of poor investment decisions and stranded assets.

Contents

3 Purpose of this document

4 At a glance: 10 thoughts for the future of low-emission mobility

6 Why now?

8 10 thoughts for the future of low-emission mobility

Purpose of this document

This document forms part of a series of 30 thoughts on the future of mobility. The thoughts represent a selection of potential challenges, opportunities and changes we believe will have tangible impact in our cities.

In developing these thoughts, we have consulted a range of Arup and external thought leaders, and considered the potential implications across next generation mobility pricing, low-emission, shared, connected and autonomous mobility.

Some thoughts are specific to their area, while others transcend their assigned category into other areas. This document is intended to increase awareness, foster collaboration and develop discussion around the opportunities and challenges that our societies will face in the near, medium and potentially far future.

At a glance

10 THOUGHTS FOR THE FUTURE OF LOW-EMISSION MOBILITY

AT A GLANCE: 10 THOUGHTS FOR THE FUTURE OF LOW-EMISSION MOBILITY

01 02 03 STRATEGY
04 05 06 07 PLANNING
08 09 10 TECHNOLOGY

01 THE TIME TO ACT IS NOW

With a climate crisis upon us, mass mobilisation for green industrialisation, technology advancement and a desire to 'come back better' post COVID-19, now is the time to plan, develop, invest and implement.

02 GLOBAL ACTION ON AVIATION AND MARITIME

Aviation and Maritime need to be part of the low-emission story. They have a large potential for efficiency and emission improvements and require innovation and partnership.

03 DEVELOP A CONSISTENT NARRATIVE

Marketing matters. Words matter. If Low-Emission Vehicles (LEVs) are going to become mainstream, we need a co-ordinated and consistent narrative that doesn't make them sound like future-age machines.

04 CREATE ULTRA LOW EMISSION ZONES

Ultra Low Emission Zones (ULEZ) have proved successful by imposing a fee on vehicles that don't meet the emission standards to enter a delineated zone or area.

05 RE-IMAGINE THE FUELLING EXPERIENCE

What if petrol stations became low-emission refuelling stations incorporating vibrant community spaces providing energy resilience, mobility options and community services?

06 PLAN FOR INCLUSIVE LOW EMISSION MOBILITY

New technology has a habit of trickling down from the rich to the poor, vehicles are no different. But what if the first mass market vehicles were buses and taxis?

07 CREATE A LOW-EMISSION TRANSITION PLAN

As vehicles and fleets of all sizes transition to low and zero emission vehicles, we need a roadmap to guide decision-making and infrastructure spending.

08 DECARBONISE THE FLEET

Zero-emission buses can make a huge difference to quality of life in urban areas. Widescale conversions should be used as a way to rebrand buses.

09 TAKING A SYSTEMS APPROACH

Battery efficiency is improving and batteries are becoming part of the circular economy. Vehicle batteries can help manage grid demand when they retire, extending the lifecycle of their most precious materials.

10 CONNECT TO CONNECTED AND AUTONOMOUS VEHICLES

Personal and fleet operated CAVs will likely have different refuelling demands and schedules. Planning for vehicles of the future while accommodating the needs of today will be key.

Why do we need to act?

Cities, transit authorities, airports, ports and utilities are quickly trying to get ahead of the trend towards low or zero emission mobility (LEM). This includes electrification and transition to hydrogen power, along with other low or zero-emission mobility services that require new or unique infrastructure. Acting proactively is imperative to capturing the growing interest in LEM, and ensuring we aggressively transition the mobility sector away from carbon-emitting energy sources.

IF SHAPED PROACTIVELY WIDESPREAD ADOPTION OF LEM COULD:

- Reduce carbon emissions and improve air quality
- Reduce operating costs and save money
- Encourage sharing infrastructure, vehicles, and resources
- Reduce downtime and servicing of vehicles
- Integrate infrastructure into the urban realm, seamlessly and efficiently
- Site infrastructure more efficiently, reducing public realm impacts
- Increase energy reliability and resilience
- Improve mobility for everyone and encourage mode shift

IF LEFT UNCHECKED, THE WIDESPREAD ADOPTION OF LEM COULD:

- Continue to increase maintenance costs and downtime
- Cause energy grid failure
- Exacerbate sprawl and car ownership
- Increase pollution
- Lead to redundant infrastructure
- Discourage active travel and human-centred spaces
- Decrease transportation equity

Three areas for thought leadership

STRATEGY

At a high-level, city, state, national, and international governments are committing to aggressive carbon reduction goals. Thoughts within the ‘Strategy’ section relate to how governments can progress toward implementation in the LEM space.

PLANNING

Stepping down from strategy, Planning focusses on making specific investments and commitments to infrastructure, land use, zoning, and network changes that will enable LEM transition and unlock potential to accelerate decarbonisation of transportation systems.

TECHNOLOGY

LEM transition involves adopting and adapting to new technologies. In doing so there is a potential to create virtuous cycles that unlock further decarbonisation opportunities, create circular economies, and support transport and energy network resilience.

▲

FUTURE OF MOBILITY

DCityPilot operates even more safely, efficiently and comfortably than conventional buses. Connectivity plus camera and radar systems with data fusion are catapulting the city bus into the future.

01 The time to act is now

With a climate crisis upon us, mass mobilisation for green industrialisation, technology advancement and a desire to ‘come back better’ post COVID-19, now is the time to plan, develop, invest and implement.

NO REGRETS DECISIONS

- Create a decision-making framework that incorporates climate change as a key factor
- Draft city and regional-level climate mitigation and adaptation plans
- Governments should lead by example by reducing air travel and replacing their fleets with zero-emission vehicles
- Support global coalitions and partnerships which raise awareness, invest in technologies and encourage organisations to commit to low-emission goals

ZERO-EMISSION, NOW

Global warming is likely to reach 1.5°C between 2030 and 2052. Even if we stopped emissions today, global warming would continue to happen for at least several more decades. This lag is why we can’t afford to wait until global warming really hits us, we need to transition to a zero-emission economy now.

REVIEW, REVISE, AND REDESIGN

Zero-emission transition requires dramatic changes in our transport system, and some are already underway. According to Bloomberg New Energy Finance, globally, 57% of all passenger vehicle sales and over 30% of the global passenger vehicle fleet will be electric by 2040. Now is really the time to review, revise and redesign our mobility and energy systems to make sure relevant transition actions are integrated.

A POST COVID-19 WORLD

COVID-19 has had a dramatic impact on how people and goods move around our cities and countries. Many countries, individuals and organisations are calling for the recovery phase to help us turn a corner in the fight against climate change. Zero emission vehicles must play a central role in a greener future, especially in the context of a temporary spike in private vehicle use.

Case study

THE CLOCK IS TICKING – DEADLINE 2020 ROADMAP

Arup supported C40 in developing *Deadline 2020*, a roadmap for implementing the Paris Agreement and creating a pathway to keeping global warming below 2°C at the city scale. A key strategy is electrifying everything in our cities. Among the key tools include low-emission zones, rolling out charging stations, zero-carbon public transport, improving freight systems, and low-emission truck programmes – many of which are in line with these ideas.

STRATEGY

02 Global action on Aviation and Maritime

The Aviation and Maritime industries have an important part to play in the low emission transition story.

NO REGRETS DECISIONS

- Consider approaches which support demand management, newer aircraft technology including fuel types and more efficient operations
- A global carbon offsetting scheme for aircraft operators is set to start in 2021, becoming mandatory in 2027, and run alongside improvements in engine technology and efficiency
- Carbon reduction and air quality programmes focus mostly on operational emissions but there is an increasing recognition of the need for whole-life carbon impact of airports and ports
- The scale and complexity of operations means that effective engagement and partnership is crucial to deliver improved carbon outcomes.

THE OPPORTUNITY

Through large scale hydrogen and electrification projects, these industries can help reduce the carbon footprint of consumer goods as they move around the globe. Ports and airports can also be testbeds for innovation in the LEM space.

Pre Covid-19, Aviation was one of the fastest growing sources of nitrogen dioxide emissions. In February 2016, the first CO_2 standards for aircraft were agreed.

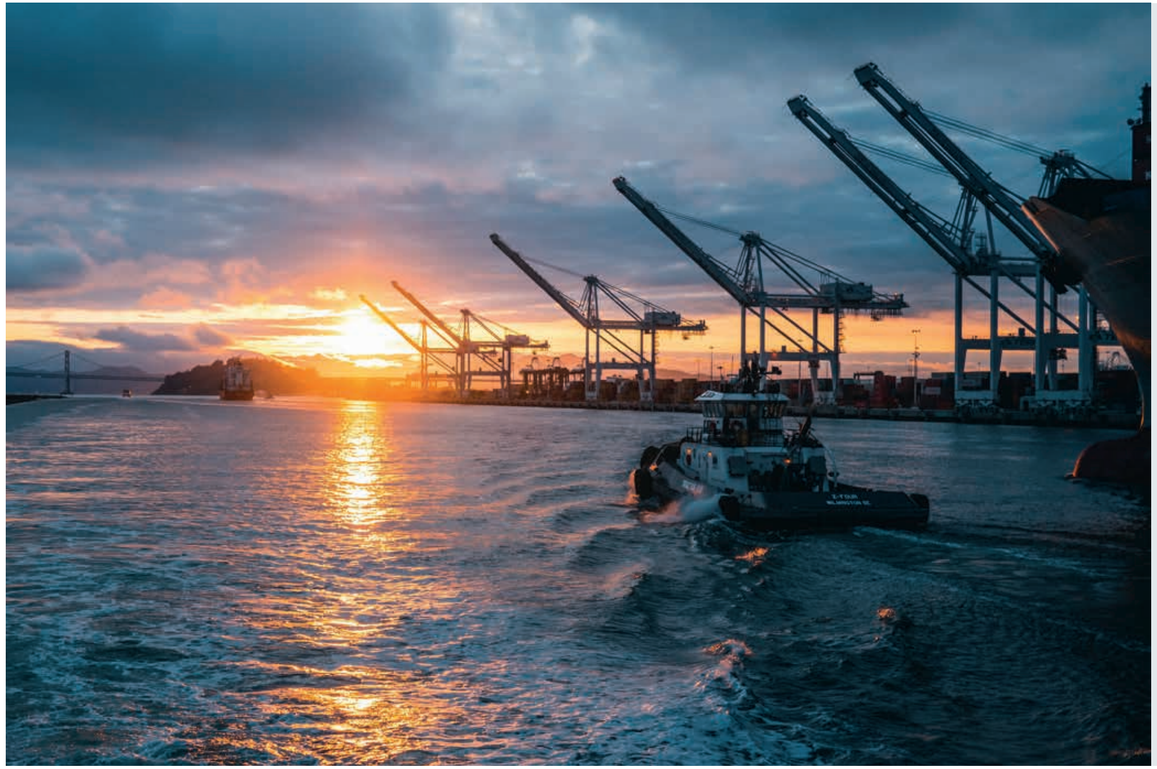
International Maritime shipping is not currently covered by emission targets and has a large potential for emission improvements.

INNOVATION AND PARTNERSHIPS REQUIRED

Sustainable growth of the Aviation and the Maritime sectors are an economic opportunity, as they directly allow for reducing operational costs of airlines, airports, shipping and ports in terms of energy use and low carbon outcomes. It is mainly through innovative technologies that these sectors can find decisive answers to these challenges.

POST COVID-19 OPPORTUNITY

As the Aviation industry prepares for sweeping changes in post-pandemic travel, how we respond becomes extremely important. A “green” recovery can build the foundation for a greener, cleaner future.



Case study

TAILORED ROADMAPS AND AUDITS

Arup is developing low emission roadmaps for individual airports and ports to deliver their low-carbon targets. Arup provides science-based guidance for clients about both operational and whole-of-life assets and guides airports and ports to achieve their carbon and low emission mobility goals in the short, medium and long term. Audits are done to measure progress on economic, low carbon and public health KPIs, depending on priority.

STRATEGY

03 Develop a consistent narrative

Marketing matters. Words matter. If Low Emission Vehicles (LEVs) are going to become mainstream, we need a co-ordinated and consistent narrative that doesn't make them sound like future-age machines.

NO REGRETS DECISIONS

- Use consistent terms within shared geographies
- Encourage cities, energy providers and elected officials to do the marketing
- Urge auto makers and charging operators to align around consistent technology and terminology

CHANGING THE LANGUAGE

"Range anxiety", "Duty cycle", "Level 1, 2, 3", "Plug-in hybrid", "Fuel cell". The language around low-emission mobility can be confusing. Clear and consistent language can go a long way to help dispel myths and expand the market.

WATCHING THE MONEY

The global auto marketing industry is a billion-dollar industry and it isn't slowing down. The traditional focus on internal combustion engine vehicles is changing and the same goes for the energy industry. Cities, states and countries have the power to speed up this shift.

GROWING A LOW-EMISSION, GREEN-ENERGY WORKFORCE

Education and training is one of the critical enablers of this work because cities need to create the next generation of problem solvers, critical thinkers, and the associated capabilities.

Case study

SPREADING THE WORD(S)

As with any major behaviour change program, we cannot spend all our time designing the interventions; we need to work equally hard to convince the public. In addressing traffic fatalities, Arup worked with NYC to normalize the language around traffic safety through community workshops and web-based tools.

04 Create Ultra Low Emission Zones

An Ultra Low Emission Zone (ULEZ) imposes a charge on all vehicles that don't meet the emission standards required to enter the delineated zone or area.

NO REGRETS DECISIONS

- Estimate the potential impact of ULEZ given the local driving and traffic patterns
- Explore the potential of incorporating ULEZ with congestion charging
- Identify the most cost-effective implementation strategy for the city
- Develop and communicate a clear plan of how fees collected from ULEZ would be used for the benefits of the public

INTERNALISING THE ENVIRONMENTAL IMPACTS OF DRIVING POLLUTING CARS

Globally, 26 cities have made pledges to ensure a major area of the city is zero emission by 2030. London created the ULEZ in the existing congestion charging zone to reduce the public exposure to air pollution created by traffic in London in particular hotspots. By operating in the existing Congestion Charge Zone, ULEZ could be useful for bridging policy ahead of an outright future ban. Cities around the world have also tried or tested other options to tackle traffic pollution and poor air quality, including Copenhagen and Munich's car-free zones, and Oslo's on-street parking ban.

CHALLENGING FOR CITIES STARTING FROM SCRATCH

Part of why London is the first in the world to initiate ULEZ is its already in-effect Congestion Charging Zone. It builds on the long-term public acceptance of pricing and the technology that enabled the Congestion Charging Zone.

LOW EMISSIONS AND PEDESTRIANISED ZONES

COVID-19 has shown cities what is achievable in terms of pedestrianisation and active travel. Improving air quality in inner cities is fundamental to health and wellbeing and must be considered in our future way of life.

Case study

ROAD CHARGING, REVISITED

Arup supported Think Tank Centre for London in creating the new vision of road pricing for the city. The congestion charging zone was expanded to include low emissions zones over time, but now there is a need to consider multiple modes, shared services, and digital technology. Our integrated team provided cross-cutting strategies that consider transport, economic, digital and planning principle.

PLANNING

05 Re-imagine the fuelling experience

By re-imagining the traditional fuelling station, community hubs can be created which deliver a low-emission ‘one-stop shop’ user experience as well as the opportunity for new business models.

NO REGRETS DECISIONS

- Develop standard site design guidelines for community mobility/energy hubs
- Design and deploy test hubs in early EV adoption communities where space is available and charging is in great demand
- Consider incentives for communities to convert parking lots and on-street parking to charging hubs or charging parklets

RE-IMAGINING THE IMAGE AND USE OF THE FUELLING EXPERIENCE

Gas or petrol stations are not known for being community amenities. By replacing the fuel tanks, fumes, and noisy idling cars with solar panels and a variety of mobility options, charging stations can become integrated energy hubs that restore vibrancy to communities.

ENABLING SPACE EFFICIENCY AND ADAPTABILITY

A multifunctional charging/fueling station would enable significant space efficiency and adaptability by co-locating different uses in the same physical space. Amenities such as bike/scooter storage, package pick-up/Amazon lockers, local retail, fleet charging, transferring e-commerce goods to last-mile vehicles and more could all be installed at charging stations.

Case study

ELECTRIC VEHICLE CHARGING FORECOURTS, UK

Arup worked with Gridserve in the UK to develop a concept for ‘charging forecourts’ which bring together solar generation, battery storage, charging infrastructure and user amenities such as coffee shops, grocery stores, lounges, and high-speed internet.

06 Plan for inclusive low-emission mobility

Social equity and accessibility should always be at the centre of low-emission mobility discussions.

NO REGRETS DECISIONS

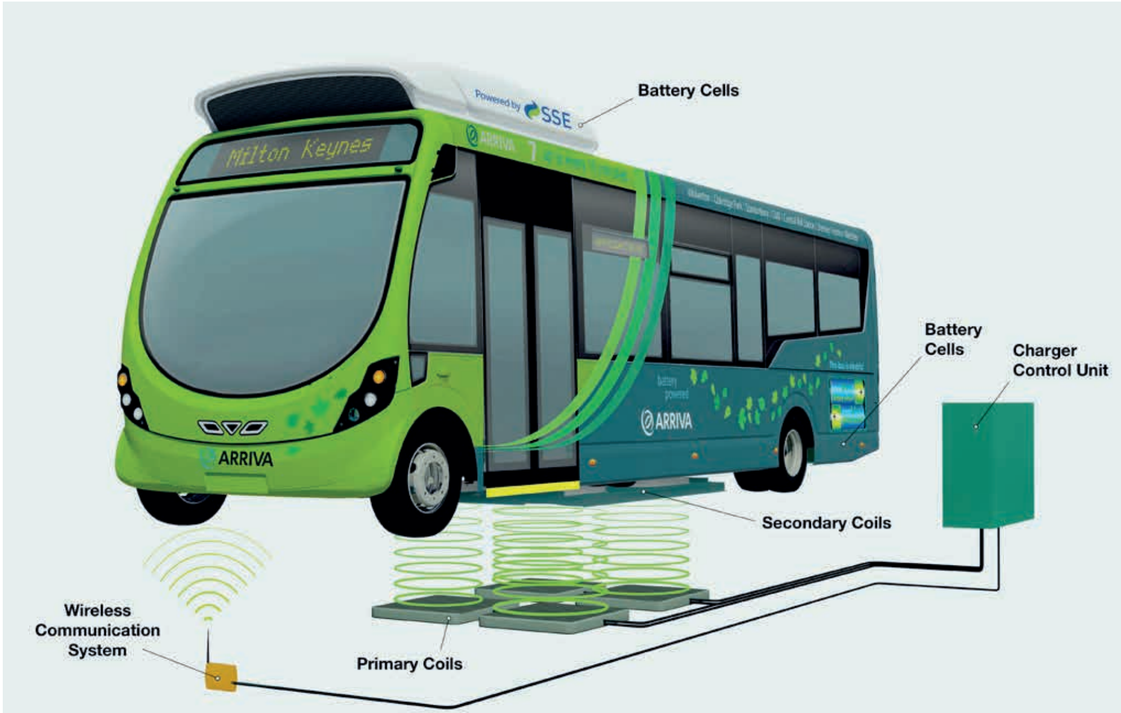
- Design incentives and deterrents to encourage freight operators to convert to low-emission fleets
- Redesign bus depots to incorporate low emission charging/fuelling
- Build low-emission refuelling stations in low-income and minority neighbourhoods

LOW EMISSION TRUCKS TO CUT POLLUTION AND EMISSIONS

Low-income and minority residents are often disproportionately impacted by air pollution and carbon emissions due to the concentration of high-polluting industrial facilities, power plants, and truck use in their communities. Switching to low-emission vehicles can reduce congestion and idling-based pollution.

INVESTING IN CLEAN AND LOW-EMISSION TRANSIT

Low-emission mobility doesn't need to and should not be restricted to only high-income communities. Electric/fuel-cell transit services can provide low-income communities access to clean and low-emission mobility while potentially yielding benefits of reduced car ownership and congestion.



Case study

JUSTICE IN THE DRIVER'S SEAT

New technology should not simply serve as a toy for those who can afford it. In the spirit of people-first planning, we focus on walking, cycling, and transit, and then making vehicles more efficient. In investing in technology that facilitates zero emission trucks and buses, we are spreading the benefits to all, and ensuring that we undo the damage of previous land use and transport miscalculations.

07 Create a low-emission transition plan

A well-designed roadmap can help harness the availability of electric and hydrogen fuels and ensure a policy-guided and user-driven transition process.

NO REGRETS DECISIONS

- Analyse market growth and budget implications and plan roll out accordingly
- Develop supportive policies to guide charging/fuelling locations
- Set planning targets for quantity, type and distribution of infrastructure
- Capitalise on opportunities to install infrastructure during road and building improvements, and ensure adequate future-proofing for future technology upgrades

TYPE OF INFRASTRUCTURE

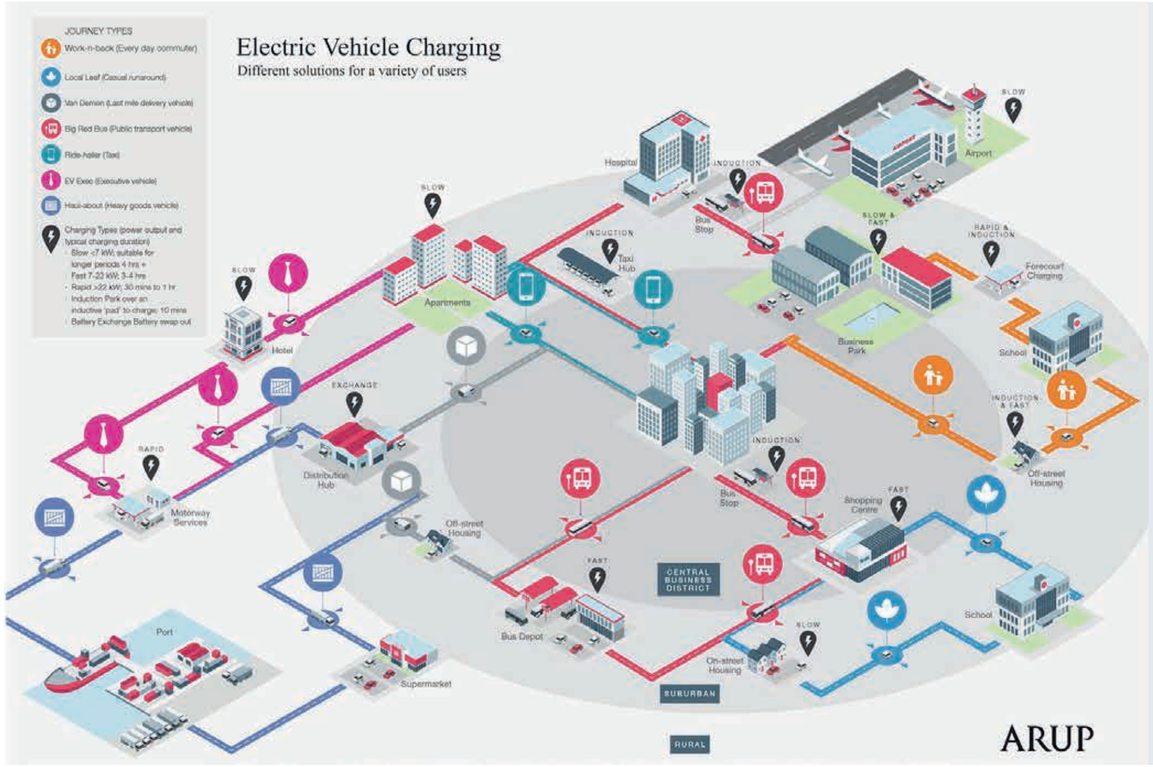
Urban areas need a mix of charging types, from slow to fast, to match less regular driving behaviour, support fleets, and manage grid demand. Larger vehicle fleets must determine if electric, hydrogen, or a mix is best for their user profiles.

LOCATION OF INFRASTRUCTURE

Wide and consistent distribution of infrastructure provides confidence, as does visible and prominent infrastructure. When sited correctly it can benefit all, not just intended users.

FLEXIBILITY OF INFRASTRUCTURE

Just as users have different behaviours, so do vehicles. Infrastructure should be able to respond to different demands by time of day, type of vehicle, and surrounding grid demand.



Case study

PLANNING THE ROLE-OUT OF RAPID CHARGING

The UK government announced the Rapid Charging Fund in the 2020 budget as part of a £500 million commitment to electric vehicle (EV) charging infrastructure. We were commissioned to advise on the electrical grid infrastructure requirements to accommodate EV charging at UK Motorway Service Areas (MSAs) until 2040. Our work has focused on 113 MSA sites in England, and the grid connection costs associated with those sites to inform the size of the required government funding.

08 Decarbonise the fleet

Facilitate the transition to low emission vehicles for fleet owners.

NO REGRETS DECISIONS

- Cities and fleet operators should set actionable and time-bound targets
- Start by electrifying some routes/fleets as a pilot programmes
- Create clear procurement and financing plans
- Develop training programmes for fleet operators
- Incorporate end-of-use planning for fleets and batteries early on

PUBLIC-PRIVATE PARTNERSHIPS TO ADDRESS FINANCIAL CHALLENGES

Early low-emission fleet adopters often face significant financial challenges, including high procurement costs, demand charges, and infrastructure and operational costs. Public private partnership with innovative financing tools could help resolve these barriers.

UPGRADE CHARGING INFRASTRUCTURE

Access to charging is another challenge facing the fleet operators. Depending on the technology maturity and economic and energy capacity, fleet operators have two charging options: depot charging or on-route charging. Both charging solutions require service-wide infrastructure upgrades.

Case study

TRANSITION WITH RESILIENCE IN MIND

Electrifying a bus fleet requires more than just procuring electric buses. A resilient energy system is also a critical component of a smooth transition. Arup is supporting Martha's Vineyard Transportation Authority (VTA) to realise the goals of its "Electric Drives the Future" programme, involving the transition of its entire fleet to electric vehicles and fuel the fleet with renewable energy and integrated energy storage. This project allows VTA to utilise microgrids to optimize electric vehicle charging, reduce demand charges, and provide transit resilience in the event of a widespread power outage.

TECHNOLOGY

09 Take a systems approach to transition

Transitioning to low-emission mobility requires changes across the ecosystem and throughout the system's lifetime, from manufacturing to operating, financing to training and infrastructure planning to end-of-life design.

NO REGRETS DECISIONS

- Cities should develop lifecycle analysis frameworks for vehicle and battery businesses
- Incentivise manufactures to design products with the end-of-life solutions in mind
- Provide consistent regulation and industry standards for vehicle deployment, infrastructure implementation and energy system upgrade
- Increase system interoperability to build users' trust and support system resilience

CROSS-SYSTEM COLLABORATION TO ADDRESS EARLY ADOPTERS' CONUNDRUM

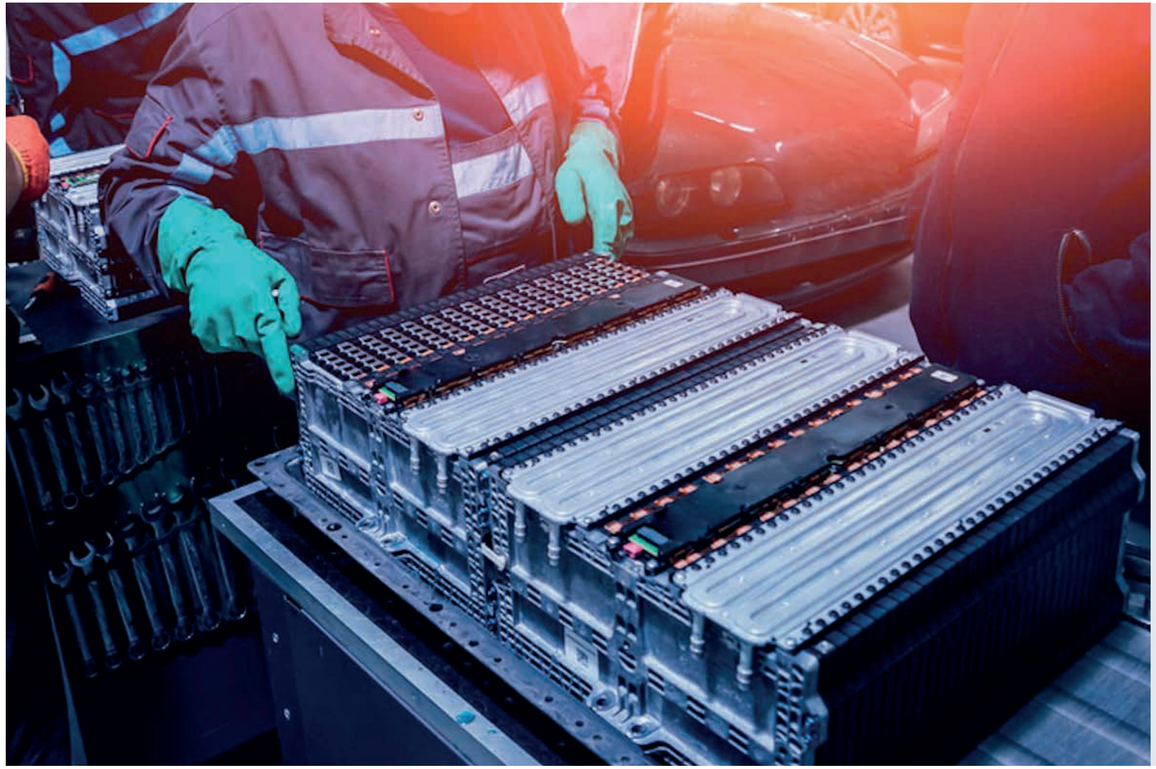
Early adopting businesses and users of low-emission vehicles often face high upfront costs and technology uncertainties. Stakeholders across the system should collaborate to enable innovation, optimise infrastructure investments and accelerate adoption to meet the climate goals.

ASSESSING IMPACTS THROUGHOUT THE LIFECYCLE

Understanding upstream and downstream environmental and economic impacts would help avoid shifting the burden from one stage to another and one country to another in a vehicle or a battery's life.

EXTENDING VALUES VIA CIRCULARITY

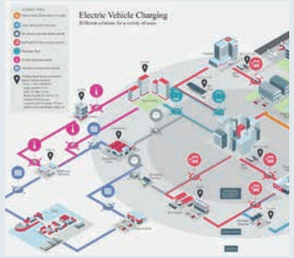
As the battery technology advances, users can either extend the use, lease, sell or reuse it as storage after their vehicles reach the end-of-life. It creates additional value for businesses and reduce the total life-cycle cost of EVs for the users.



Case study

GIVING BATTERIES A SECOND CHANCE

Recent market studies suggest that the market for EV battery recycling could be a billion dollar industry. While batteries used in vehicles have high demands on charging time, they still have plenty of life remaining when they are replaced. What if we used the batteries we take out of vehicles to store energy in our homes, or at a wider scale, as part of the clean energy grid?



10 Connect to Connected and Autonomous Vehicles

Personal and fleet operated CAVs will likely have different charging demands and schedules. Planning for vehicles of the future while accommodating the needs of today will be key.

NO REGRETS DECISIONS

- Continue investing in battery chemistry to increase the battery density and efficiency
- Launch a pilot with an autonomous vehicle fleet to explore the infrastructure and logistical needs
- Develop policies and strategies to convert shared service fleets (e.g. taxis) to electric vehicles (EVs) as a first step
- Design and implement a centralised platform that tracks, communicates and facilitates electricity supply among vehicles

AVAILABILITY, TYPE, AND DISTRIBUTION ARE KEY

Connected and autonomous fleets have higher requirements and reliance on charging stations due to their high-mileage use and electricity needs from the built-in system. Therefore, it is important to provide a well-distributed network that meets the frequent charging needs. For CAVs that are used for sharing or e-commerce services, reducing locating and charging time is especially important to limiting non-revenue generating times and achieving cost parity with gas-powered vehicle.

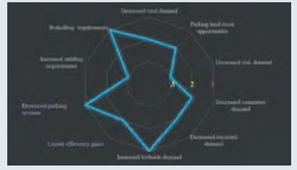
ENABLING CHARGING TECHNOLOGIES TO SUPPORT ENERGY RESILIENCE

Energy reliability and resilience is critical to CAV adoption. Vehicle-to-vehicle and vehicle-to-grid charging technologies could enable ‘peak shaving’ (sending power back to the grid when demand is high) and ‘valley filling’ (charging at night when demand is low), which ultimately would reduce demand from the grid, balance the peaks and valleys, support power generation from renewables, and provide excessive capacity for unplanned disruptions.

Case study

HELPING INFRASTRUCTURE VICTORIA UNDERSTAND THE IMPACT OF AVS AND ZEVS

P reparing for change is critical. Arup helped Infrastructure Victoria understand the likely impacts of Autonomous Vehicles (AVs) and Zero-Emission Vehicles (ZEVs) on Victoria’s road users and network, identifying strategic priority plans for the Victorian government to act now to prepare for the future. Arup assessed the risks and opportunities of AVs and ZEVs and identified the requirements for adaptable infrastructure from a ‘whole lifecycle’ perspective, including the design, build, operation and maintenance.



ARUP

The 10 thoughts for the future of low-emission vehicles are part of a wider set of ideas from Arup on the future of mobility. Other documents include:

- 10 thoughts for next generation mobility pricing.
- 10 thoughts for the future of shared, connected and autonomous vehicles.

If you'd like to speak to us about any of our thoughts, contact: smartmobility@arup.com

Or visit www.arup.com