

“CLIC” Mobility

A Climate Transition for Transport in a post-COVID world

05/20

May 2020

USD 2 trillion transport investment will be required annually over the next decade to generate sustainable economic growth and to align with the Paris Agreement and UN SDGs

p.3

At a glance

- Our mobility system is wildly out of control and urgently needs to transition to a CLIC (Circular, Lean, Inclusive, Clean) model, which could generate USD 2 trillion per annum in savings.
- We estimate CO₂ emissions may fall 4-8% in 2020 and road transport emissions c14%, as a result of COVID-19 travel restrictions. But to reach the 1.5°C target of Paris Agreement, total greenhouse gases (GHG) must fall 7.6% per annum by 2030 and transport emissions almost halve by 2050. This requires decoupling emissions growth from the increasing demands for the mobility of people and goods, which will be vital for future economic growth.
- As lockdowns ease, “building-back-better” will support a more sustainable economic recovery – to prevent a return to business-as-usual and increased congestion, air pollution, a shift away from shared mobility and unsustainable freight & delivery traffic.
- The pandemic-pause presents a unique opportunity to rethink city space – to question the purpose and necessity of each trip, to devote less space to the car and focus on the health, lifestyle and economic benefits of greener spaces, resilient infrastructure, increased active and shared mobility and more sustainable first and last-mile deliveries.
- We expect a multi-modal shift to electric vehicles, micro-vehicles, Mobility-as-a-Service (MaaS) and rail to present multiple investment opportunities, as well as provide decarbonisation benefits.
- We believe regulation will drive greener long-haul transport innovation (ammonia for shipping, syngas for aviation and hydrogen for trucks & rail). A greater focus on lifecycle emissions and circularity in vehicle production and usage – material efficiencies, battery reuse and recycling, vehicle-to-grid – will allow transport to dematerialize, reduce waste, improve resource efficiency, reduce emissions and support a growing urban population.
- We see digitalisation as a key enabler of the Transport Revolution – supporting greater resilience of infrastructure from physical risk, protecting against future supply chain disruptions, allowing more seamlessly-integrated personal and freight transport ecosystems, enabling remote working and presenting multiple investment opportunities for zero-emission technologies.

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Please read important information at the end of this document.

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Transport urgently needs to decarbonise, while decoupling from the demands of economic growth. Market forces are now in the driving seat – technology is a key enabler but also consumer taste and investor pressure.

1. Executive summary

1. Many cities experienced dramatically cleaner air during the COVID-19 lockdown period, in no small part helped by the reduction in transport-related emissions.¹ Is this transport decline here to stay, or will corporates and consumers just return to the status quo as soon as travel restrictions are lifted?
2. At Lombard Odier we embrace the clearer skies and forecast a 4-8% drop in CO₂ emissions in 2020² (the largest decline on record). We estimate that this could include a 14% decline in road transport emissions.³
3. However, **to meet the most stringent goals of the Paris Agreement by 2050⁴ (which have now been enshrined into law in many jurisdictions), we urgently need a 7.6% annual reduction in total GHG⁵ emissions over the next decade, even as conditions return to a new “normal.” This will also be critical for the increasing number of corporates to achieve the net-zero targets stipulated.**
4. Mobility – the way people and goods move – sits at the heart of our economy and lifestyles. Mobility is an economically critical sector, and will continue to be, even in a net-zero world. Fossil fuels are still deeply embedded in our current mobility model, which will require a profound and urgent transformation towards a **CLIC (Circular, Lean, Inclusive, Clean) model**.
5. In our view, this mobility revolution is already underway. With lockdowns beginning to ease, and signs of a resurgence in air pollution in some regions,⁶ the big question now is whether we will see a return to business-as-usual for transportation and a return to emissions growth in a post-COVID world.
6. While short-term commuters may shy away from public transport and personal car usage may surge, we believe the transport revolution will continue, fundamentally reshaping how people and goods move around. Many cities (such as Paris, London and Madrid) are implementing schemes to discourage car usage post-lockdown and encourage active mobility and we also expect a renewed focus on shared mobility and zero-emission freight.
7. This creates significant investment opportunities as the transition to a sustainable mobility model continues to unfold.

“Multiple levers will be required to ensure this transition can occur – electrification is one key solution, but for some heavier, long-haul transportation this will not be sufficient. Hydrogen, ammonia, synfuels, and a drastic shift in both transport mode and demand will all be necessary solutions. We expect the Transport Revolution and behavioural shift in mobility to present multiple investment opportunities across myriad industries: technology and data (Internet of Vehicles – IoV), infrastructure, micromobility, mobile payments, mobility-as-a-service, hydrogen, green buildings, and the electric vehicle supply chain. But it will drive systemic risks for others.

Hubert Keller, CEO, Lombard Odier Investment Managers & Managing Partner, Lombard Odier Group. ”

Sustainable transport can deliver USD 2 trillion annually⁷

Transport directly accounts for **14% of current global emissions** – emissions that are proving **“hard-to-abate”** for many heavy-duty and long-distance trips.

¹ The scientists of the Global Carbon Project (GCP) calculated that on peak lockdown day (7 April) CO₂ emissions were 17% lower than 2019's daily average.

² International Energy Agency Accessed at: [https://www.iea.org/reports/global-energy-review-2020/global-energy-and-co₂-emissions-in-2020](https://www.iea.org/reports/global-energy-review-2020/global-energy-and-co2-emissions-in-2020) and Bloomberg Green, *Biggest Fall in Global Emissions Shows the Limits of Individual Action*, 19/5/2020. Accessed at: <https://www.bloomberg.com/news/articles/2020-05-19/how-has-covid-19-affected-climate-change-co-emissions?srnd=green-energy-science>. The Global Carbon Project forecasts a 2-7% drop in 2020 emissions if the world gets back to prepandemic conditions by mid-June and a 3-13% drop if restrictions stay in place all year.

³ Bloomberg New Energy Finance *Electric Vehicle Outlook 2020*, 19 May 2020.

⁴ To limit temperatures, annual emissions in 2030 need to be 15 gigatonnes of CO₂ equivalent lower for a 2°C goal; they need to be 32 gigatonnes lower for a 1.5°C goal. On an annual basis, this means cuts in emissions of 7.6% per year from 2020 to 2030 to meet the 1.5°C goal and 2.7% per year for the 2°C goal: <https://www.unenvironment.org/news-and-stories/press-release/cut-global-emissions-76-percent-every-year-next-decade-meet-15degc>.

⁵ GHG = Greenhouse gas emissions that absorb and emit infrared radiation in the wavelength range emitted by Earth. GHG include Carbon dioxide (CO₂) but also nitrous oxide, methane and ozone trace gases.

⁶ <https://www.cbsnews.com/news/coronavirus-china-lockdown-over-air-pollution-already-spiking-industry-dirty-economic-rebound/and-crea-china-s-air-pollution-rebound-tracker>.

⁷ LOIM estimates based on analysis in United Nations, *Mobilizing Sustainable Transport for Development*, November 2016 and Zhao, X., Mahendra, A., Godfrey, N., Dalkmann, H., Rode, P., and Floater, G., 2015: The New Climate Economy – Technical Note: Unlocking the Power of Urban Transport Systems for Better Growth and a Better Climate (http://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Unlockingthe-power-of-urban-transport-systems_web.pdf).

Emissions are set to rise sharply in future years⁸ driven by **increasing demands for personal mobility and freight**. We see the theme of transportation **as a cross-cutting theme that will affect multiple industries and sectors**.

- How and why people and goods move is becoming ever-more relevant in a world blighted by pandemic and recession, and intersects with multiple sustainability dynamics including **human development, digitalisation, dematerialisation, zero emissions, fair society, and resource efficiency**.
- Enforced lockdowns due to social-distancing could provide a once-in-a-lifetime opportunity to rethink city space. Building Smart Cities⁹ means developing new ways to use space and encouraging shared, and more active, forms of mobility to **enable greater connectivity** amongst and between businesses and consumers without increasing the risks associated with a more carbon-constrained and carbon-damaged world.
- Some cities, such as Paris, Milan and London¹⁰ are already looking at how to reallocate mobility-related spaces **away from cars** (roads and parking) and **devote more to "soft" transport** (walking, cycling, micromobility) and sustainable living – such as Berlin's temporary street closures in 2019 to enable children to play.
- The development of Smart Cities may help to ease some of the pressures created by the trend towards greater urbanisation, but some sectors, like commercial and retail real estate, may come under threat. Mobility is a vital cog in future economic development and recovery globally. However, future mobility needs to be **equitable, accessible, resource-efficient, resilient, cost-effective and clean to be sustainable**.
- This will require a **regulatory push, enabled by technology** but should also present a **USD 2 trillion annual opportunity to investors over the next decade**¹¹ and upside for corporates and consumers as market forces and technology advancements create efficiencies in transportation and delivery.
- USD 2 trillion transport investment will be required annually over the next decade to generate sustainable economic growth and

to align with the Paris Agreement and UN SDGs. But this could generate USD 2 trillion annual transport savings due to reduced spending on fossil fuels, lower capital investment, a reduction in losses due to congestion,¹² savings on operating expenses related to vehicles and road infrastructure. Additional benefits include avoided costs of pollution and resultant health savings,¹³ as well as improvements to safety and efficiencies in cross-border transport and supply chain resilience, which could generate a global GDP increase of USD 2.6 trillion.¹⁴

The COVID-19 crisis presents an opportunity to "build back better"?

- The COVID-19 crisis presents an opportunity to "build back better" as the transport sector recovers and helps to stimulate future economic growth.
- However, the danger is that a disorderly recovery results in newer, dirtier transportation habits (such as increased use of personal vehicles versus public transport for hygiene reasons). In our view, the crisis is more likely to prove a catalyst for further acceleration, rather than a hindrance to progress. **Electric vehicle penetration is close to a tipping point** and technology improvements mean that **life-cycle emissions** are now lower for battery electric vehicles (BEV) than combustion engine cars (ICE). **Sustainable raw material sourcing** and **end-of-life battery recycling** options are also becoming much more widely available.
- There are significant opportunities for **circularity** and **resource efficiency** in car manufacturing (60% of sheet metal in manufacturing currently goes to waste). Recycling and reuse of raw materials can further reduce emissions and extend the life of vehicles. Shared mobility models will also impact emissions.¹⁵ There are additional opportunities to couple transport and power and reduce emissions across both sectors via new technologies such as Smart Charging, vehicle-to-grid (V2G) and second-life battery use for power storage (enabling renewables expansion).¹⁶

⁸ International Energy Agency Accessed at: <https://www.iea.org/reports/global-energy-review-2020/global-energy-and-co2-emissions-in-2020>.

⁹ Smart City – an urban area that uses different types of electronic Internet of things (IoT) sensors to collect data and then use insights gained from that data to manage assets, resources and services efficiently.

¹⁰ On May 18th the London Underground carried just 8% of the passengers it did a year earlier. To prevent a resurgence of personal car usage, the Corporation of London proposes drastically changing streets to give more space to pedestrians and cyclists and to bar cars from certain roads. <https://www.theguardian.com/uk-news/2020/may/15/large-areas-of-london-to-be-made-car-free-as-lockdown-eased#maincontent>.

¹¹ LOIM estimates and forecasts; based on IEA (2019), Oxford Economics (2017).

¹² Analysis has found that congestion costs 2% of GDP in Europe and up to 10% of GDP in emerging markets: Zhao, X., Mahendra, A., Godfrey, N., Dalkmann, H., Rode, P., and Floater, G., 2015: The New Climate Economy – Technical Note: Unlocking the Power of Urban Transport Systems for Better Growth and a Better Climate (http://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Unlockingthe-power-of-urban-transport-systems_web.pdf).

¹³ Air pollution costs USD 3.5 trillion annual and half of these costs are related to road transport: Organisation for Economic Co-operation and Development (OECD), 2014: The Cost of Air Pollution: Health Impacts of Road Transport (www.oecd.org/env/the-cost-of-air-pollution9789264210448-en.htm).

¹⁴ World Economic Forum: Enabling Trade – Valuing Growth Opportunities.

¹⁵ The United Nations report *Resource Efficiency and Climate Change – Material Efficiency Strategies for a Low-Carbon Future* found that Material Efficiency can significantly reduce emissions from the material cycle of vehicle production, operational energy use and via increased shared mobility modes.

¹⁶ For further detail on the battery value chain, see the Global Battery Alliance report – <https://www.weforum.org/reports/a-vision-for-a-sustainable-battery-value-chain-in-2030>.

- In the aftermath of the COVID-19 crisis, as companies and countries gradually reopen their doors, we believe many new and cleaner modes of transport may emerge as companies focus on **supply chain risk mitigation** and embrace the **cost effectiveness of greener mobility options** for both goods and personal transportation. Consumers and corporates may find that **new travel habits stick**: the “flygskam” (flight shaming¹⁷) movement may intensify; and more questions may be raised about the necessity of each trip.
- We expect some behaviour will normalise once global travel and trade disruptions ease. In the near-term, whilst trust in public transport safety remains low, we may even see a shift to less sustainable transportation options and away from share mobility, with a **surge in personal car usage**.
- However, we expect the **cost, air pollution and congestion implications**, combined with a renewed focus not just on banning diesel cars but increasingly on encouraging a full **modal shift away from the personal car and towards smaller, shared mobility options, will drastically reshape urban areas**. We also expect increasing regulation to force fleets and long-distance transport to transition to more sustainable modes. For instance, one of the conditions of Air France-KLM's state-backed bailout of EUR 10 billion in April was that airlines must present credible emissions-cutting plans, pledge to pay tax on fuel and phase out short-haul flights where trains can realistically do the job.¹⁸
- Another key change is likely to be related to the use of **technology**, which we see as a key enabler of the Transport Transition. We expect a greater degree of public-private partnerships to ensure better integration of transport systems and enhance “seamless mobility”. However, with greater digitalisation comes **greater privacy concerns** but we expect the cost, efficiency and accessibility benefits to boost acceptance. For fleet transport, technology will also be important to improve trip efficiency and reduce urban delivery congestion.
- **Long-haul transport** is hard to decarbonise by electrification. While blended wing design and electrification are possible

solutions for short haul aviation,¹⁹ long-haul transport emissions are harder-to-abate. Here, technology developments will be required to make decarbonisation solutions (such as **ammonia, synfuels and hydrogen**) more accessible and cost-effective.

- **Physical climate impacts** (outside the scope of this whitepaper) will also impact transport, including flight and shipping routes. The **resilience of global supply chains** is heavily reliant on transport adaptability to the changing physical environment.

We expect emergency recovery packages to aid more sustainable transportation

- Land transport accounts for more than 60 million direct jobs globally. The wider mobility system accounts indirectly for up to 50 million jobs in Europe alone.²⁰ **Mobility is vital to future economic development**. But we think policymakers, particularly in Europe, may start to focus recovery packages on more sustainable mobility options to **prevent a shift away from cleaner public transport and other multi-occupancy modes** and devote more urban space to active and micromobility options.²¹ We also expect the recent surge **in remote working to become the new norm** for many.
- We expect policymakers will learn from cleaner, less congested city streets and skies brought about by the COVID-19 lockdowns. The crisis has also highlighted the significant healthcare and economic consequences of not being prepared. The only way to prepare for climate-related risks is a smooth, but rapid transition to a net-zero emissions economy across all sectors.
- We expect a renewed regulatory focus on non-road transport and on building out hydrogen infrastructure. For long-haul more expensive options such as ammonia (shipping) and synfuels (air) will be necessary, combined with a **modal shift** to increase the use of **zero-emission** rail for freight and zero-emission first and last-mile deliveries.
- At Lombard Odier, we recognise the urgent need for new regulatory approaches to both long and short-haul transportation. We believe wholeheartedly in the necessity for global

¹⁷ <https://www.bbc.com/news/world-europe-51067440>.

¹⁸ <https://www.euractiv.com/section/aviation/news/air-france-klm-gets-virus-bailout-green-conditions-still-pending/>.

¹⁹ https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_CarbonReport_20200203.pdf.

²⁰ <http://www.unece.org/info/media/presscurrent-press-h/transport/2020/greening-the-transport-sector-in-the-post-covid-19-recovery-could-create-up-to-15-million-jobs-worldwide/doc.html>.

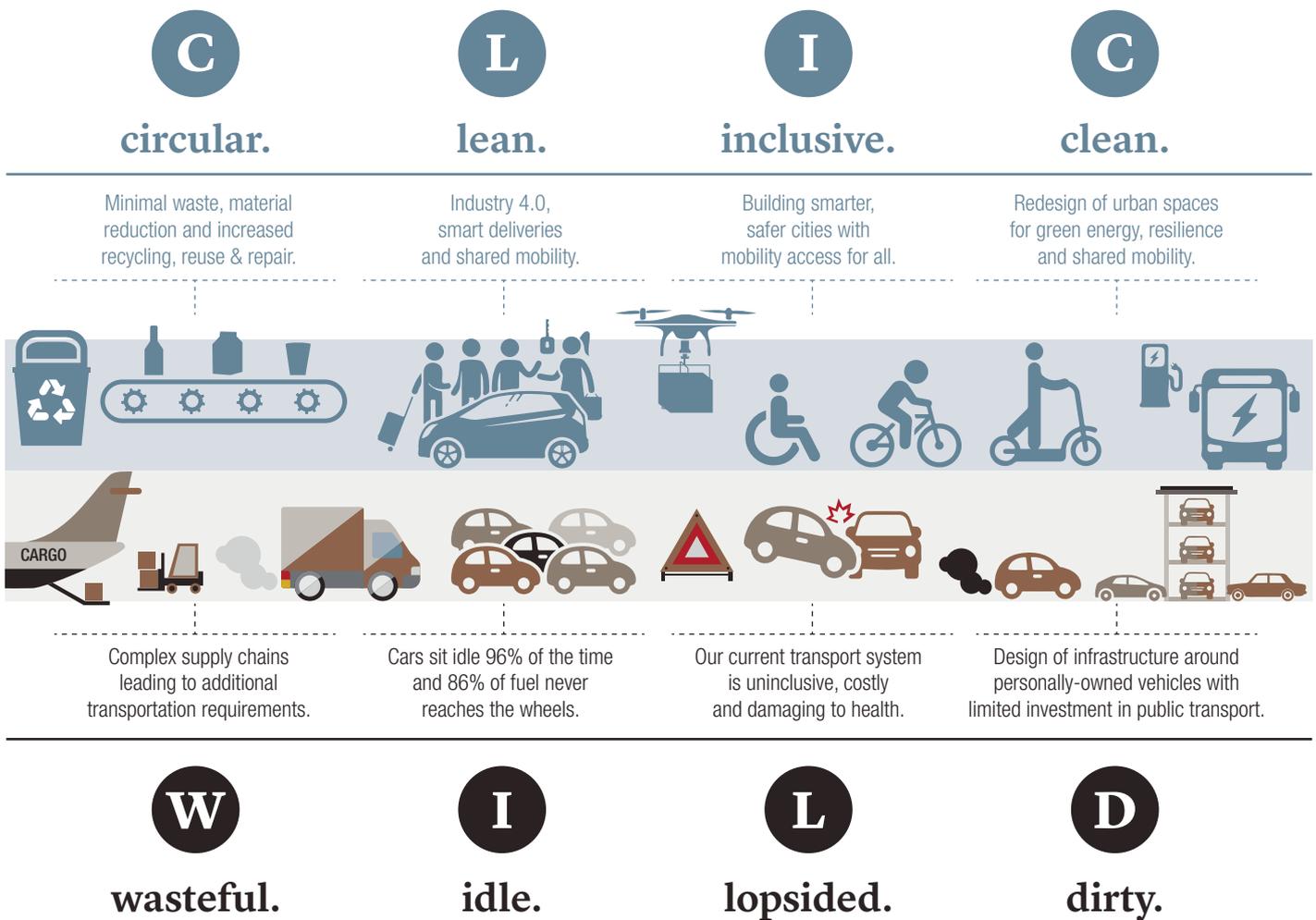
²¹ The EU's Green Recovery Package focuses on many of these areas, including a proposed EUR 20 billion clean car purchase scheme, VAT exemption for zero-emission cars and EUR 60 billion for new drivetrains. There is also a proposed Rail Investment package of EUR 40 billion and a strong focus on hydrogen investment and the Circular Economy. Accessed at https://ec.europa.eu/info/strategy/eu-budget/eu-long-term-budget/2021-2027_en.

governments to spend economic stimulus wisely and invest in the economy of the future. As such, we have endorsed the Energy Transitions Commission's (ETC) COVID-19 Recovery Statement,²² which includes "support the automotive sector

while pursuing clean air" as one of its seven priorities to help the global economy recover as well as a call for support on innovative low-carbon activities such as hydrogen and low-carbon shipping and aviation fuels.

We believe this will not only benefit the [Climate Transition](#) but will also stimulate economic growth and more sustainable health, which will ultimately benefit investors.

FIG. 1 OUR CURRENT MOBILITY MODEL IS WILD AND NEEDS TO TRANSITION MORE URGENTLY TO A CLIC MODEL



Source: LOIM. For illustrative purposes only.

²² Energy Transitions Commission (of which LO is a member), 7 PRIORITIES TO HELP THE GLOBAL ECONOMY RECOVER. Accessed at: <http://www.energy-transitions.org/content/7-Priorities-for-Global-Recovery>.

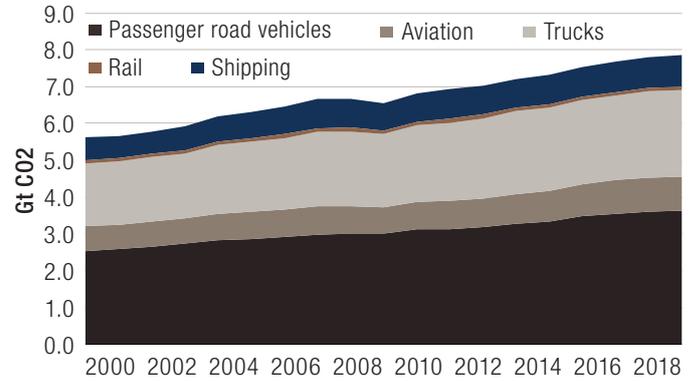
2. Setting transport in context: Long-haul transport emissions are hard-to-abate

Transport currently accounts for 14% of all global CO₂ emissions (or 9.2 Gt CO₂e²³ each year) and is one of the few sectors where emissions continue to rise yearly. It is vital to see a transition to net-zero transportation and yet to fuel economic growth, demand for freight and personal transportation is rising sharply, particularly in developing countries, which risks setting transport even further from a net-zero target. Almost half of transport emissions relate to passenger road transport but the remaining 55% are largely from long-haul travel: trucks (29%), aviation (12%) and shipping (11%) (Figure 2).

2.1. Transport transitions from WILD to CLIC

At Lombard Odier we believe our transport system is currently **WILD (Wasteful, Idle, Lopsided and Dirty)**. Pre-COVID-19, the average personal car sat idle in parking spaces for 96% of the time; the rise in online deliveries, ridehail and air travel was fuelling greater air pollution and urban congestion; and internal combustion engine vehicles (ICEs) were the predominant source of propulsion. **Transport remains one of the only sectors in Europe and the US where CO₂ emissions continue to rise**, albeit at a decelerating annual growth rate of 0.6% in 2018 (versus 1.6% annual growth over the last decade).²⁴ In 2020 emissions will likely fall sharply as a result of the enforced reduction in travel. Bloomberg New Energy Finance (BNEF)²⁵ recently forecast a 14% decline in CO₂ emissions

FIG. 3 TRANSPORT IS ONE OF THE FEW SECTORS WHERE EMISSIONS CONTINUE TO RISE GLOBALLY

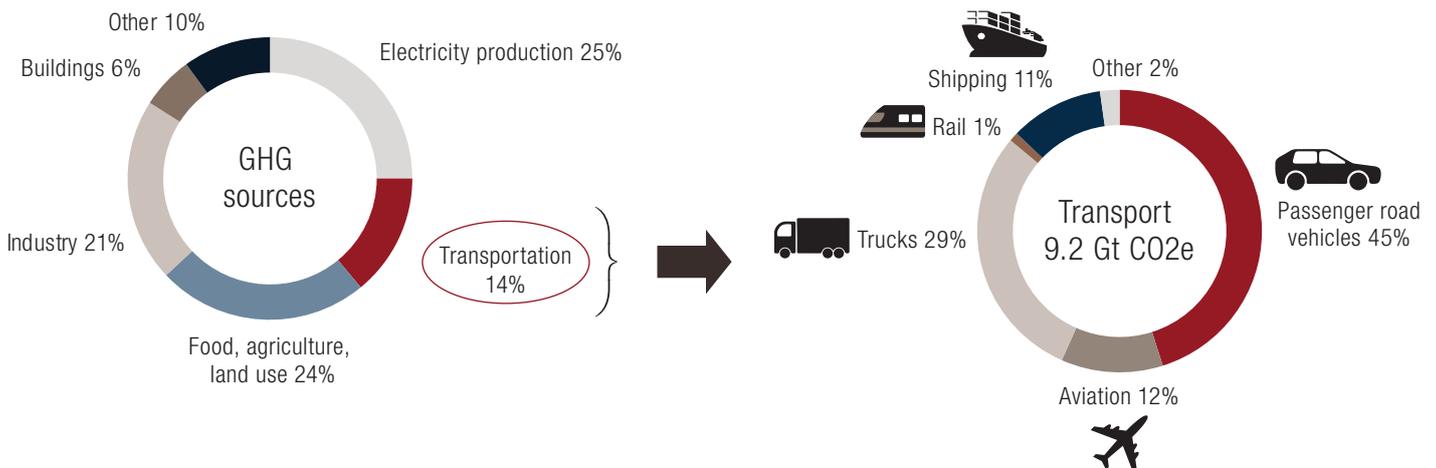


Source: IEA, Transport Tracking report 2019. NB total CO₂ emissions from transport were 8Gt CO₂ in 2018. Total GHG emissions totalled 9.2Gt CO₂e.¹⁸

from road transport as a result of COVID-19 disruption, and a full recovery by 2022 and a 6% increase (versus 2019) by 2040, despite strong electrification forecasts. This trajectory does not set transport on a path towards net-zero.

Despite the urgent transition needed in transport, the latest report from the Transition Pathway Initiative (TPI) found only 35% of transport companies are aligned with even the least-ambitious

FIG. 2 GREENHOUSE GAS (GHG) EMISSIONS FROM TRANSPORT



Source: LOIM, IEA, IPCC WG3 FAR.

²³ A gigatonne is a thousand million tonnes. "GtCO₂e" is an abbreviation for "gigatonnes of equivalent carbon dioxide." It is a simplified way to put emissions of all Greenhouse gases (GHGs) on a common footing by expressing them in terms of the amount of carbon dioxide that would have the same global warming effect.

²⁴ International Energy Accessed at: <https://www.iea.org/reports/global-energy-review-2020/global-energy-and-co2-emissions-in-2020>.

²⁵ BNEF *Electric Vehicle Outlook 2020*, 19 May 2020.

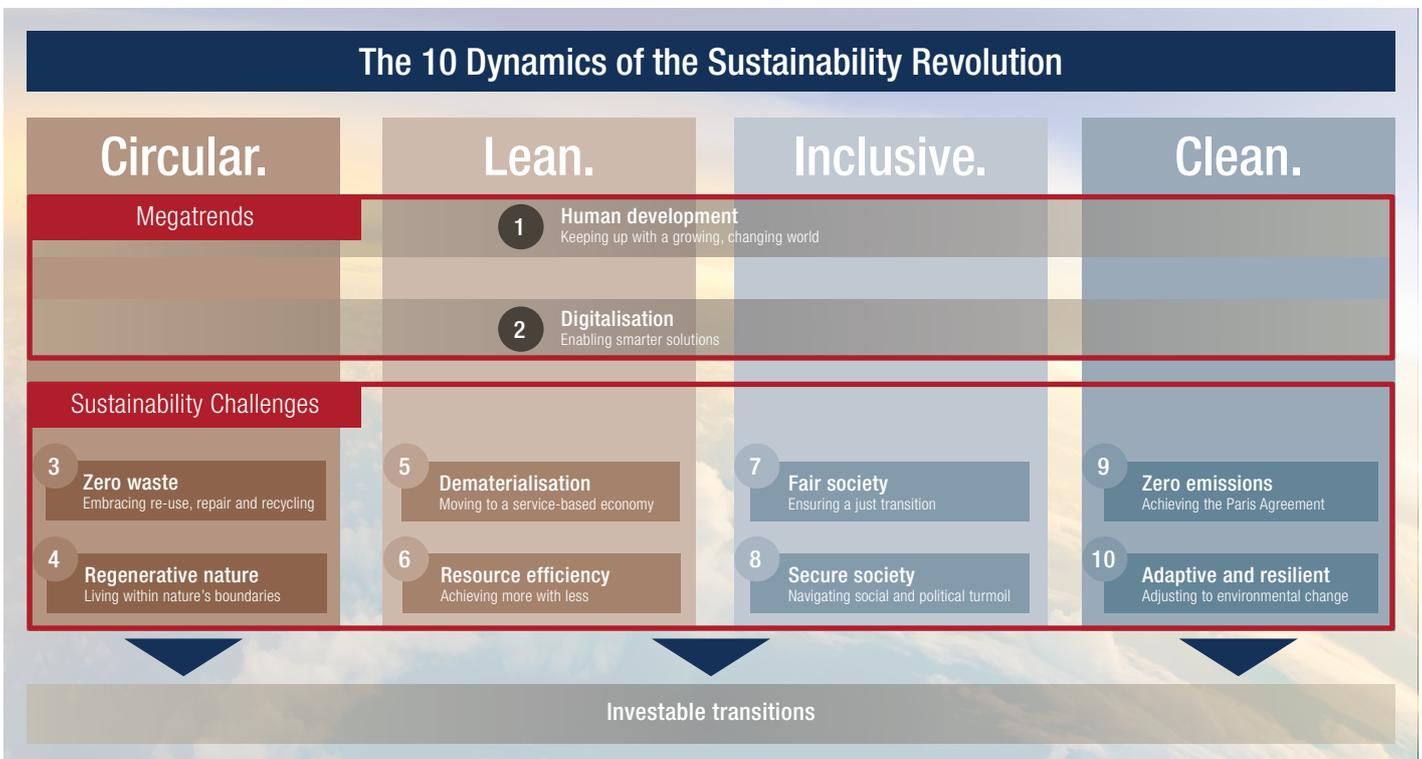
Paris-aligned benchmarks and less than one-fifth have reduction plans aligned with a path to keep global warming at 2°C or below.²⁶

In order to align with a net-zero path, transport emissions in the EU would need to fall 52% by 2050²⁷ (compared to 2015) by our calculations (see Figure 6). Transport needs to shift to a **CLIC (Circular, Lean, Inclusive and Clean) model**, whilst still enabling, and even driving, a recovery in economic growth and mobility. This will require a concerted effort by policymakers, consumers and corporates to ensure circularity in vehicle manufacturing and afterlife, leaner usage of mobility options and cleaner transportation modes, whilst also ensuring that transportation options remain inclusive for all.

Transport sits at the heart of the CLIC economy because it intersects with so many different trends and sustainability challenges. It is vital that the global economy moves to ensure a more sustainable style of personal transportation – whether that be how people commute to work or how they travel for leisure and longer trips. It is also critical to transition towards more sustainable transportation of goods, given ever-rising pressure on global supply chains and increasing appetite for on-demand delivery.

At Lombard Odier we have **identified ten key sustainability megatrends and challenges:**

FIG. 4 LOMBARD ODIER'S TEN DYNAMICS OF THE SUSTAINABILITY REVOLUTION

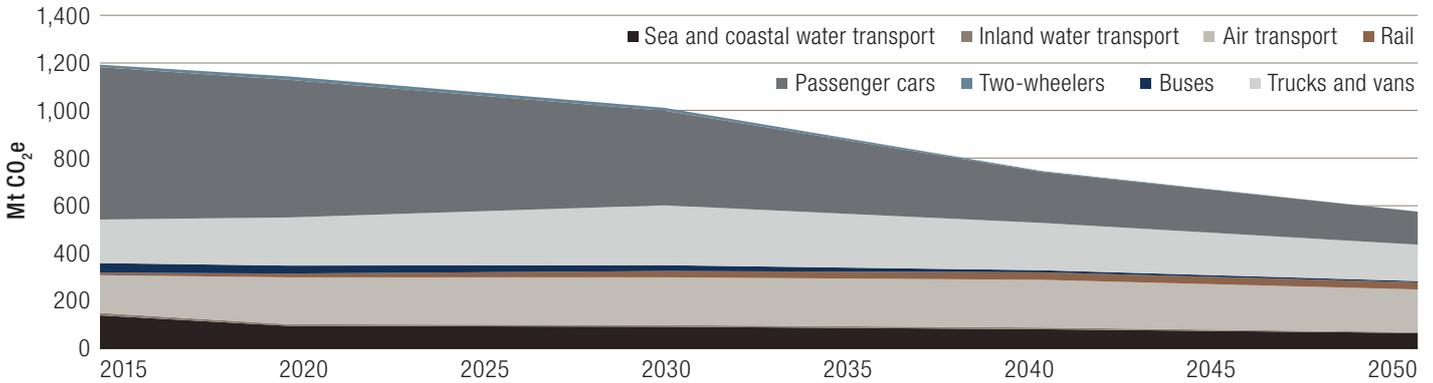


Source: LOIM. For illustrative purposes only.

²⁶ Transition Pathway Initiative: Management Quality and Carbon Performance of Transport Companies: December 2019. Accessed at <https://www.transitionpathwayinitiative.org/tpi/publications/29?type=NewsArticle>.

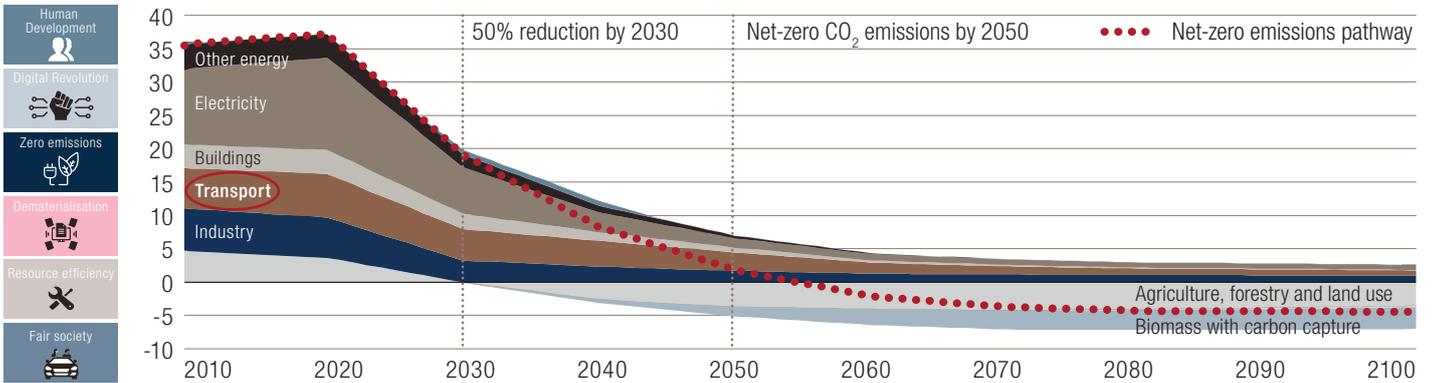
²⁷ LOIM estimates. Note that net-zero by 2050 (including all GHGs, and not just CO₂ emissions), as shown in the figure for the EU above, will require an even more ambitious reduction.

FIG. 5 ALIGNMENT WITH A 1.5°C SCENARIO WILL REQUIRE RADICAL CUTS IN EMISSIONS ACROSS ALL TRANSPORT SECTORS (EU)



Source: LOIM estimates for required cuts in emissions in different transport sectors to achieve alignment with a 1.5°C scenario.

FIG. 6 TRANSPORTATION CUTS ACROSS MULTIPLE SUSTAINABILITY CHALLENGES AND URGENTLY NEEDS TO TRANSITION CLOSER TO ZERO EMISSIONS



Source: LOIM, IPCC special Report: Global Warming of 1.5°C.

Transportation directly impacts many of these challenges. We need to ensure that transportation can keep up with the demands of **human development**, whether that be population growth in developing markets or the pressures of expanding urbanisation. **Digitalisation** trends should enable greater connectivity in transport demands – allowing commuters and fleets to source the most efficient or cost-effective routes and transport modes, improving mobile payments and, over time, enabling a greater degree of autonomy in vehicles. The move to **zero-emissions** will require radical cuts in emissions, with emissions from the transportation sector needing to fall by half by 2050 to be aligned with a 1.5°C scenario (from 9.2 Gt CO₂e

each year) – this will require huge efforts across heavy and long-haul transportation, where electrification will not suffice.

Transportation also has direct impact on the challenges of **dematerialisation** and **resource efficiency**. For many years vehicle manufacturers have been looking for lighter-weight, more sustainable materials. The transition to electric vehicles (EVs), whilst helping to reduce component content, is also putting increasing demands on chemicals for battery composition and metal-content. Technology is advancing fast and enabling a move to lower ratios of cobalt²⁸ in lithium ion batteries. For instance new passenger EVs with NCM 811 (the ratio of

²⁸ Cobalt is often controversially sourced from the DRC, a high risk area and where 20% of the country's cobalt is extracted by artisanal mines, where serious, systemic human rights violations are commonplace, including child labour. For further detail see: <https://www.unpri.org/social-issues/how-investors-can-promote-responsible-cobalt-sourcing-practices/2975.article>; <https://www.bmwgroup.com/en/company/bmw-group-news/artikel/conflict-resource-cobalt.html>; <https://www.benchmarkminerals.com/bmw-announces-it-will-buy-cobalt-directly-from-australia-and-morocco/> and <https://asia.nikkei.com/Business/Markets/Commodities/Milestone-reached-in-the-recycle-of-cobalt-from-spent-EV-batteries>. The Responsible Cobalt Initiative (RCI) was set up in 2017 to increase transparency in cobalt supply chains and the Responsible Battery Coalition aims to advance the responsible production, transport, sale and use, reuse, recycling and resource recovery of batteries and the Responsible Raw Materials Initiative (RRMI) focuses on the social and environmental impacts of extraction and processing.

Nickel:Cobalt:Manganese) battery cells comprised 18% of sales in China (7% globally) in September 2019 (up from just 1% in January 2019).²⁹ **Battery recycling options** are also improving,³⁰ to ensure greater sustainability of electric vehicles over the full lifecycle and not just at the tailpipe.

A recent report by the International Resource Panel (IRP)³¹ highlighted that GHG emissions from the material cycle of cars could be reduced by up to 70% in G7 countries and 60% in China and India by 2050 via material substitution, recycling and reuse, ride-sharing, car-sharing and a shift towards trip-appropriate smaller cars. We note that the EU recovery plan focuses heavily on the Circular Economy and we certainly believe that an increased regulatory push towards life-cycle emissions (versus tailpipe) could drive significant further innovation and emissions decline. We intend to focus in more detail on the topic of the Circularity Gap in a forthcoming whitepaper but will also discuss changes in mobility mode, towards more shared mobility, later in this paper.

But electrification of personal cars without a modal shift is not enough. From the point of view of resource efficiency, we argue that it does not really make sense for a personal car (often with single occupancy) to be used for 70% of journeys in the developed world, when 60% of those journeys are below 5 miles in length. We expect regulation and urban policymakers to begin to rethink

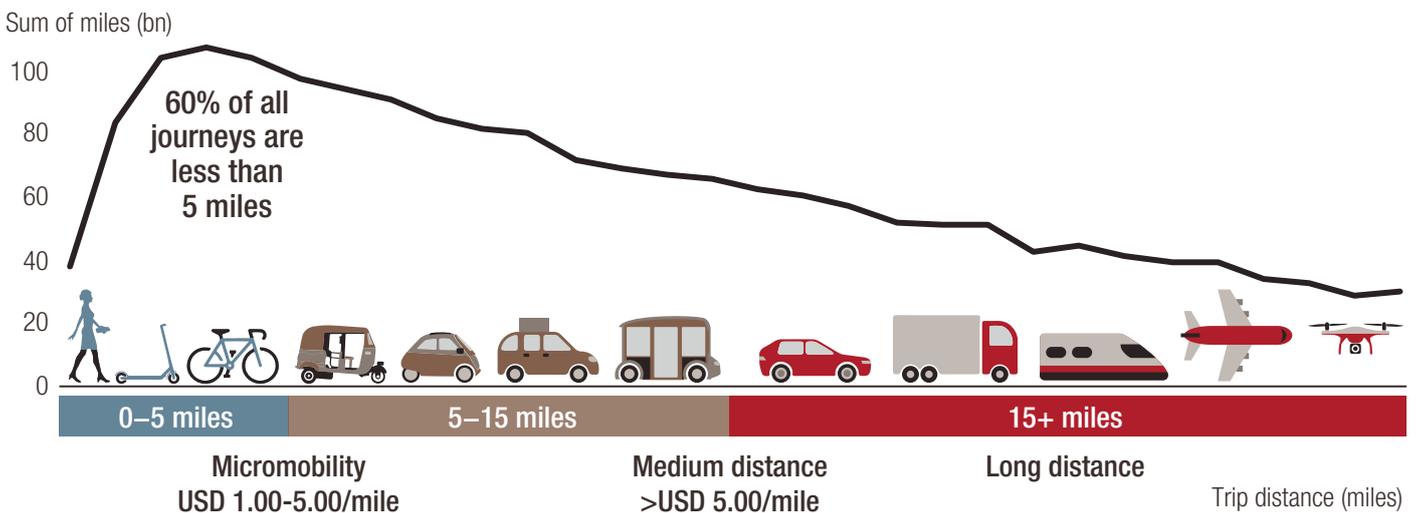
this model and encourage more active modes of transport and smaller, shared electric vehicles for short distance trips.

We believe regulation and a more conscious consumer will start to **shift this car-centric model** for personal mobility. We also expect the surge in demand for delivery fleets (food and online retail) to be met in a more sustainable way, in order to **decouple growth** in requirements from emissions.

2.2. Positive feedback loop – cleaner is becoming cheaper

Regulation is already having a disruptive impact on traditional transportation modes and demand. The auto industry was one of the first to be regulated on scope 3 emissions.³² Multiple regulations are in place globally to mitigate tailpipe emissions from cars and force the automotive industry to electrify. International governments, regulating c.85% of the global light-vehicle market, have committed to, or are proposing, **a ban on internal combustion engine (ICE)** vehicles within the next 20 years. There are low-emissions zones and bans on older cars in multiple cities globally as a result of worsening urban air quality, as well as congestion charging and parking restrictions. The issue of nitrogen oxides (NOx) was brought to public attention even more directly by 2015’s “Dieselgate.”

FIG. 7 WE NEED TO RETHINK TRANSPORT MODE, PARTICULARLY FOR SHORT TRIPS, IN ORDER TO ACHIEVE THE CONFLICTING REQUIREMENTS OF A MORE SUSTAINABLE “CLIC” TRANSPORT SYSTEM WITH INCREASED PRESSURE ON TRANSPORT DEMAND



Source: LOIM. For illustrative purposes only.

²⁹ <https://www.greencarcongress.com/2019/11/20191115-admas.html>.

³⁰ For instance, Swedish battery cell manufacturer Northvolt has recently launched Revolt, its battery cell recycling programme and targets 50% recycled material in new cells within the next decade <https://northvolt.com/newsroom/Announcing-Revolt>.

³¹ IRP (2020). Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future. Hertwich, E., Lifset, R., Pauliuk, S., Heeren, N. A report of the International Resource Panel. United Nations Environment Programme, Nairobi, Kenya. Accessed at: <https://www.resourcepanel.org/reports/resource-efficiency-and-climate-change>.

³² Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions. See: https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf.

Post-dieselgate more cities started to focus on pollution and health issues linked to combustion engine cars and diesel in particular – NOx, Particulate matter (PM 2.5)³³ and whether reported vehicle emissions (based on laboratory tests called NEDC in Europe³⁴)

bore any relation to real-life driving emissions. Not only were car makers’ fleet average emissions tests tightened in Europe under the new real-life test cycle (WLTP³⁵) but increasingly cities started to impose ICE bans to try to meet air pollution targets:

FIG. 8 MANY CITIES HAVE ANNOUNCED RESTRICTIONS FOR COMBUSTION ENGINE VEHICLES WITH AN INCREASING NUMBER BANNING ALL CARS FROM CERTAIN AREAS, OR ANNOUNCING FULL ICE SALES/DRIVING BANS IN COMING YEARS

ANNOUNCED ACCESS RESTRICTION MANDATES IN LOCAL JURISDICTIONS



- Diesel access restrictions
- Fossil-Fuel-Free Streets Declaration
- ICE sales ban
- ICE access restrictions

Source: National and local statistics and press reports. www.C40.org, 17 cities globally have declared restrictions on high-polluting vehicles that cover a significant part of the city. These include the Crit’Air scheme in Paris since July 2015, London’s congestion charge and ULEZ (and temporary car restrictions post-lockdown) and Oslo with access restrictions in place already for ICEs in the city centre. For illustrative purposes only.

³³ <https://friendsoftheearth.uk/clean-air/diesel-and-air-pollution-10-facts-about-invisible-killer>.

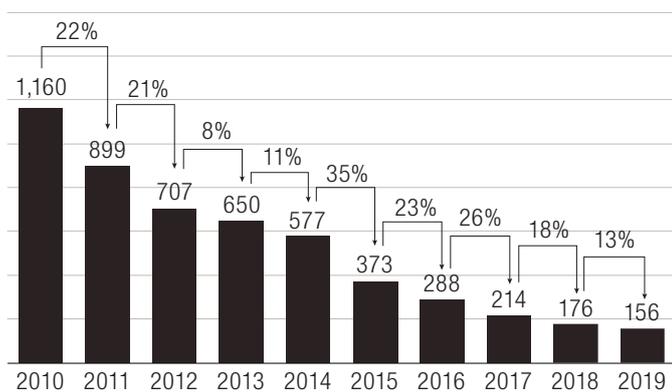
³⁴ https://www.transportenvironment.org/sites/te/files/media/T&E%2098-3_0.pdf.

³⁵ <https://www.sciencedirect.com/science/article/pii/S2352146517306403>.

Global regulation for short-haul transport is getting ever-more stringent, particularly in Europe and China. The car industry is one of the sectors where policy has advanced fastest. In fact, regulation accelerated before consumers were ready and will soon be forcing carmakers to sell more electric vehicles than consumers want to buy. Despite the growing availability of electric vehicles, consumer expectations (including range-anxiety) remain a critical challenge for the electric vehicle industry to overcome. However, we expect consumer reticence to shift over the next few months, especially if the next round of emergency recovery packages provide stimulus for electric vehicles (EVs).³⁶

Shifting consumer preferences are a significant driver of change for transportation. For shorter trips, EV charging infrastructure is improving, albeit the roll-out and density of such networks has thus far remained uneven, often hampered by unclear policies and the lack of national action plans. We expect global recovery packages (and in particular the EU’s Proposed Green Recovery Package) to focus on investment into clean infrastructure and further incentives for electric vehicle purchases. Over time as the consumer grows more comfortable with range-anxiety, as charging infrastructure builds and battery chemistry improvements supply additional range, and as electric vehicle prices fall and consumers grow savvier about the lower total cost of ownership (TCO) of a BEV (even at low oil prices), we expect EV penetration to rise sharply. For longer distance trips, environmental consciousness about the effects of long-distance travel (e.g. “flight shaming”) continues to increase, even if COVID-19 lockdowns have frustrated many from taking planned vacations by air.

FIG. 9 BATTERY CELL COSTS HAVE DECLINED RAPIDLY (c90%) SINCE 2010
REAL 2018 USD



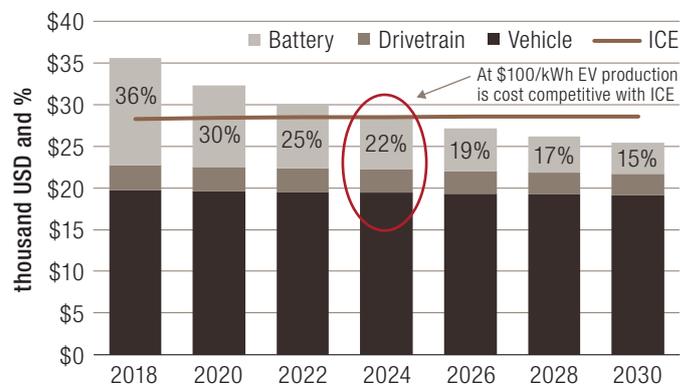
Source: BNEF.

Increasingly, **technology is taking the driving seat** as the most powerful force behind the personal transport revolution. Regulation provided the initial impetus and consumers are beginning to show greater support but it is only now that **battery costs** are reaching a tipping point, where electric vehicles are almost as cheap to manufacture as internal combustion vehicles (ICEs).

The 90% fall in battery costs since 2010 is now enabling automakers to see a tipping point within reach. We believe **this tipping point comes when battery costs fall to USD 100/kWh**, the point at which a mid-sized electric vehicle will cost the same to manufacture as an ICE. This point could be reached sooner, with increased regulatory support via EV subsidies. And as we will discuss below, an earlier tipping point will be reached by consumers who work out the lower TCO of a BEV, even at higher upfront prices. But once technology enables this cost parity, without reliance on incentives, we think **EV penetration is set to increase more rapidly than third-party forecasts assume** and that many automakers will switch to EVs faster than forecast, assuming battery capacity and raw material supply can ramp fast enough.

This powerful feedback loop of “cleaner becoming cheaper” will also encourage more consumers to switch to EVs, particularly if local and national incentives encourage them further. It is also when this tipping point is in sight that **investors can see the significant opportunities from cleaner personal vehicles. If the market is underestimating adoption rates for electrification**, this may present **opportunities along the EV supply chain** – lithium, separators, cathodes, graphite, assembly machines, battery suppliers, vehicle manufacturers, charging infrastructure, semiconductors and green buildings.

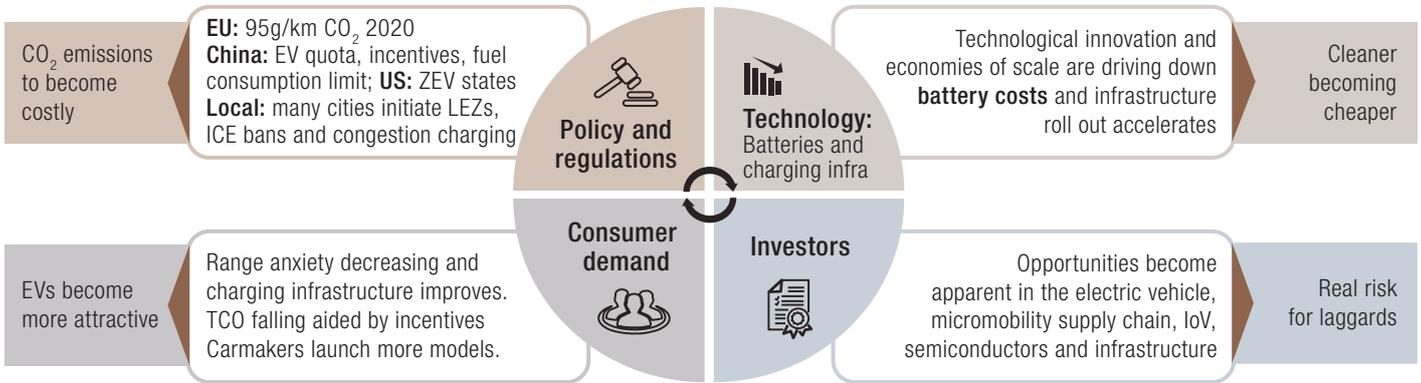
FIG. 10 AND BATTERY COSTS SHOULD REACH A “TIPPING POINT” IN THE MID-2020’S WHEN EV PRODUCTION COSTS (FOR A MID-SIZED CAR, EX-INCENTIVES) ARE ON A PAR WITH COMBUSTION ENGINE CAR (ICE) PRODUCTION COSTS



Source: LOIM, Barclays Capital, BNEF.

³⁶ <https://www.euractiv.com/wp-content/uploads/sites/2/2020/05/Green-Deal-Recovery-Package.pdf>, and <https://electrek.co/2020/05/26/france-makes-evs-central-to-an-8-8-billion-plan-to-rescue-its-auto-industry/>.

FIG. 11 THE TRANSPORT REVOLUTION IS FUELLED BY A POSITIVE FEEDBACK LOOP OF POWERFUL MARKET FORCES – “CLEANER IS BECOMING CHEAPER” AND INVESTORS CAN SEE OPPORTUNITIES IN THE GREEN MOBILITY SPACE



Source: LOIM. For illustrative purposes only.

2.3. Electrification a solution for cars and smaller vehicle fleets

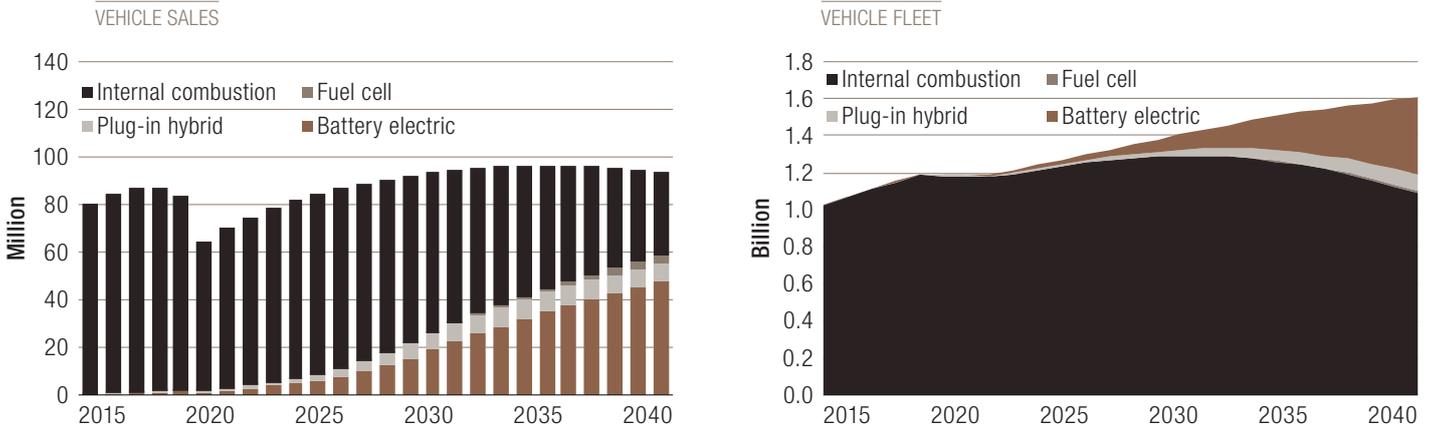
We are close to a tipping point where car manufacturers want to switch to full electric production, in order to achieve global CO₂ fleet emission targets, and where consumers are more comfortable with the concept of driving and charging an electric vehicle.

The tipping point may be approaching, whereby we are reaching “peak ICE” in the global fleet of cars on the road but to date, even the most optimistic third party forecasters, such as BNEF, still assume that ICE (i.e. CO₂ emitting vehicles) will comprise 70% of the vehicles on the road over the next two decades.³⁷ However, **to align with a net-zero, 1.5°C scenario, we need to see global**

transport emissions stabilise in the near term and fall by half to 2050. We are almost at the limit of vehicle efficiency potential for the combustion engine, so we either need to see a faster shift away from the ICE, or a total shift in demand away from single-occupancy car trips.

We will show below (Figure 29) that the cost proposition for the consumer of an average EV is already attractive, even in a world of lower oil prices. However, for higher rates of EV penetration, we need to see an acceleration in vehicle (and battery cell) production, as well as a shift in consumer acceptance of the new technology. But we remain convinced that as a result of policy support and battery cost declines, current EV vehicle penetration forecasts may fail to fully capture the speed of the transition.

FIG. 12 THIRD PARTY FORECASTERS, SUCH AS BNEF, ASSUME ‘PEAK ICE SALES’ IN THE MID-2020’S, BUT STILL ASSUME ICE ARE 40% OF VEHICLE SALES AND 70% OF THE FLEET BY 2040. FOR A NET-ZERO PATH, THE ICE NEEDS TO BE PHASED-OUT MUCH MORE RAPIDLY



Source: BNEF.

Note: ICE = internal combustion engine, BEV = Battery electric vehicle, PHEV = plug-in hybrid vehicle.

³⁷ Bloomberg New Energy Finance, Long Term Electric Vehicle Outlook 2020, 19 May 2020.

We are also aware that electrification by itself will not suffice and that there is an urgent need to also to rethink personal transportation mode and usage.

There is also work to do to ensure the full lifecycle “greenness” of electric vehicles in terms of using zero-emissions electricity and battery recycling.³⁸ But technology is enabling great advances in these fields and **BEVs are now more sustainable** over the full lifecycle than an equivalent ICE (see Figure 14).

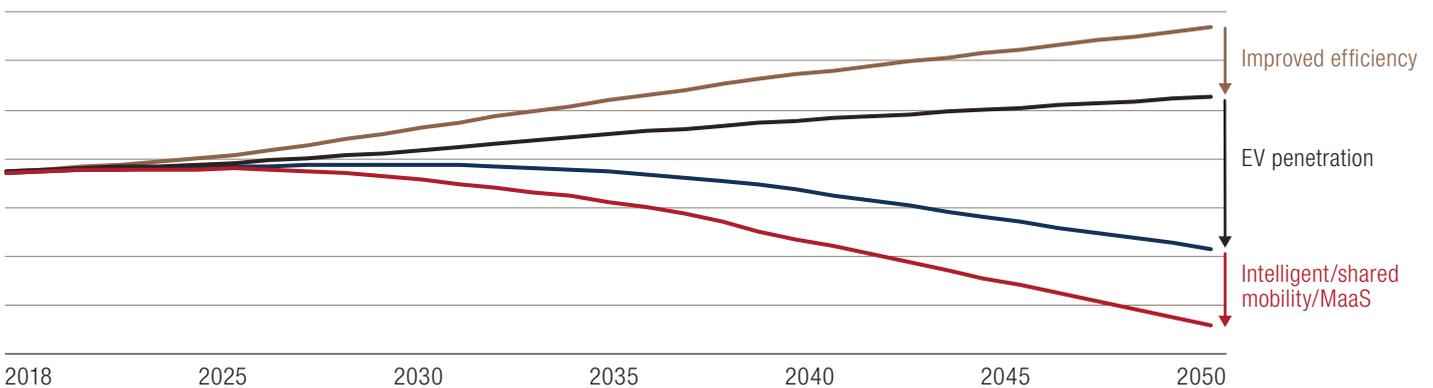
To date, most transport regulations continue to focus on tailpipe emissions as the main lever of change. Simplistically, electric vehicles provide the solution due to their zero-emission nature. However, tailpipe emissions (CO₂ and NOx) and thus air quality

improvement is only one of the many sustainability challenges facing the transport sector and its supply chain. As policymakers become more attuned to the needs of the climate transition, we expect the next transition could be towards policies focused on full life-cycle vehicle emissions, requiring increased attention to upstream supply chains and manufacturing efficiencies.

In order to assess the investment opportunity for electric vehicles, we believe it will become increasingly important to focus on full lifecycle emissions (Scope 3 and increasingly “Scope 4”/saved or avoided emissions), thus also capturing the energy-intensity of the raw material extraction, battery and vehicle manufacture and the power source used to charge the electric vehicles (from well-to-wheel), as well as the after-life of the components.³⁹

FIG. 13 PERSONAL TRANSPORT MUST DECOUPLE GROWTH IN TRANSPORT DEMAND FROM EMISSIONS – THIS CAN BE ACHIEVED PARTLY BY VEHICLE AND OPERATIONAL EFFICIENCIES, PARTLY VIA ELECTRIFICATION BUT TO GET CLOSER TO ZERO-EMISSIONS, INCREASED SHARED AND INTELLIGENT MOBILITY WILL BE REQUIRED

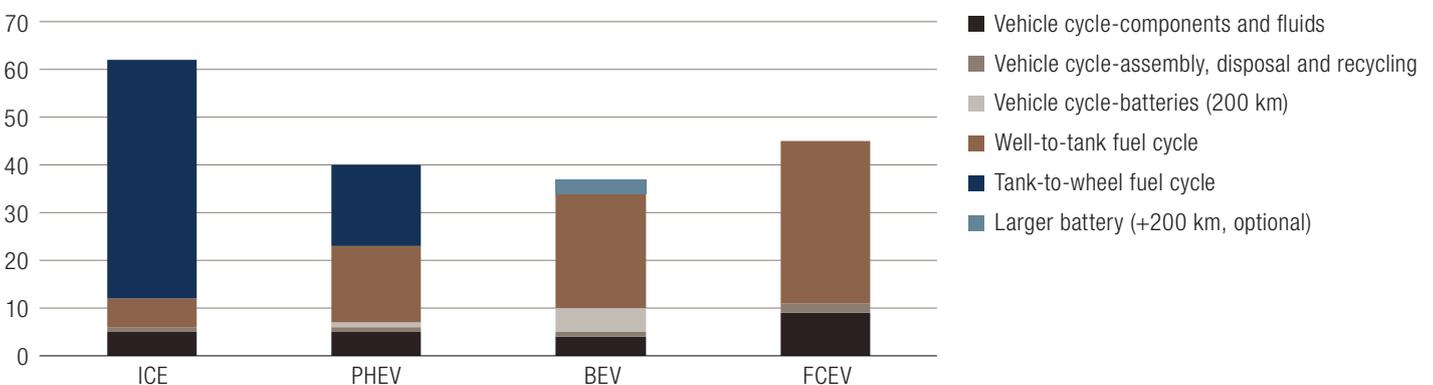
PERSONAL TRANSPORT EMISSIONS PATHWAYS



Source: LOIM, for illustrative purposes only.

FIG. 14 LIFECYCLE EMISSIONS DEPEND ON MANY FACTORS, INCLUDING RAW MATERIAL SOURCING AND COUNTRY POWER SOURCE, BUT SIGNIFICANTLY LOWER ‘TANK-TO-WHEEL’ EMISSIONS OF ELECTRIFIED CARS AND IMPROVEMENTS IN BATTERY CHEMISTRY AND RECYCLING SHOW THAT EVS ARE LOWER EMITTING THAN ICE OVER THE FULL LIFECYCLE

COMPARATIVE LIFE-CYCLE GHG EMISSIONS OF A MID-SIZE GLOBAL AVERAGE CAR BY POWERTRAIN, 2018



Source: IEA.

³⁸ See footnote 7.

³⁹ For a more detailed discussion on electric vehicle environmental credentials, see: <https://www.forbes.com/sites/jamesellsmoor/2019/05/20/are-electric-vehicles-really-better-for-the-environment/#da3560976d24>;

There are already clear winners along the automotive supply chain who focus on solutions to decarbonise and improve the sustainability of the lifecycle of electric vehicles. Solutions range from improvements in battery cell chemistry to reduce the reliance on cobalt⁴⁰ and rare earth metals, battery recycling,⁴¹ vehicle-to-grid (V2G), renewable material sourcing, wind-energy powered production⁴² etc. Automakers need to position themselves as transitioning businesses. The best positioned auto makers will be those that transition fastest to become net-zero mobility service providers and those that look beyond tailpipe emissions to full lifecycle sustainability.

However, as electric vehicle battery cell costs fall and upfront investments in electric architectures peak, we believe **personal transport electrification can provide near-term investable opportunities**. The businesses fastest to react to this transition, with dedicated platforms for battery electric vehicles (BEVs) and a clear vision across the supply chain for sustainable material sourcing, will be best able to capture the electric opportunity.

2.4. Alternative solutions are required for most long-haul, heavy transport

Electric vehicles are quickly becoming a cost-effective, zero-emission solution for light duty transport. But passenger vehicles account for only half of all transport-related emissions (see Figure 2), while long-haul, heavy-duty transport accounts for the remainder, split between road (29%) and rail freight (1%), aviation (12%), and shipping (11%).

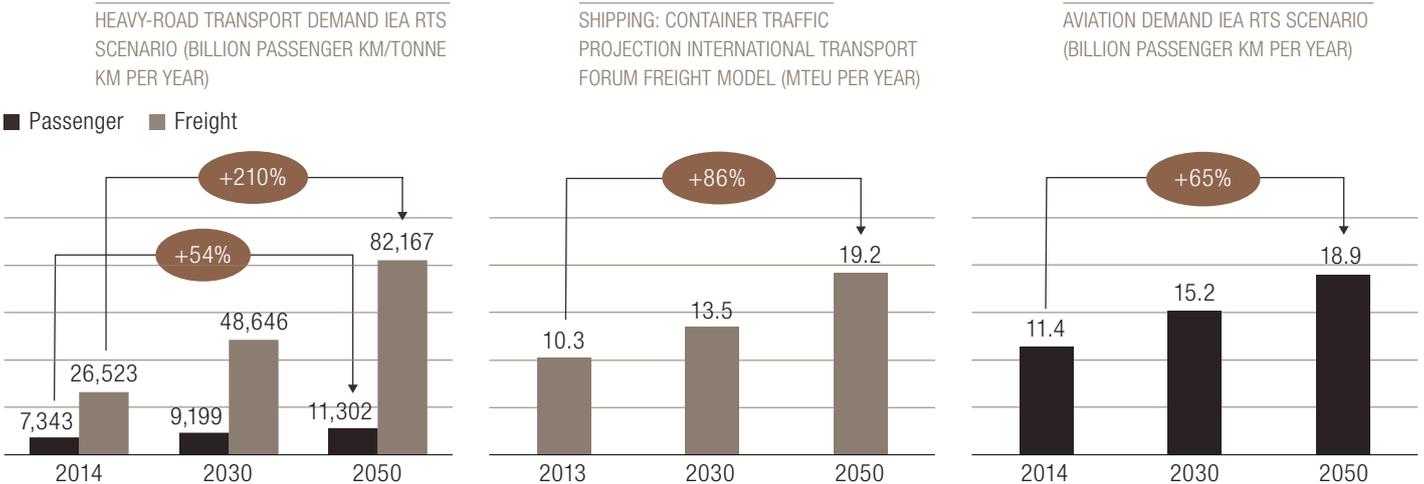
For short-haul aviation, innovation in vehicle design (such as blended wing design) and vehicle electrification are making decarbonisation increasingly possible. But in order to keep trade flowing and international supply chains uninterrupted, **long-haul transport growth is vital for future economic growth**. In order to reach the goals of the Paris Agreement, we must urgently find solutions to decarbonise **harder-to-abate**, long distance and heavy-duty transport, not just personal road transport. Prior to the COVID-19 crisis, demand for long-haul transport was forecast to grow exponentially over the next few decades, with particularly strong demand coming from developing markets in Asia:

FIG. 15 DECARBONISATION OF AIR TRANSPORTATION



Source: Volokopter, Lilium, Zunum, Pipistrel, NASA.

FIG. 16 LONG-HAUL TRANSPORT DEMAND IS SET TO GROW SHARPLY BUT DEMAND MUST BE DECOUPLED FROM EMISSIONS GROWTH



Source: IEA 2017, Energy Technology Perspectives; OECD (2017), ITF Transport Outlook 2017.

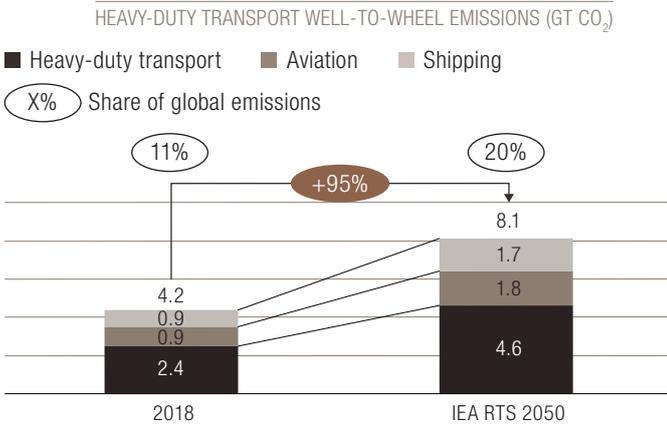
⁴⁰ Cobalt is often controversially sourced from the DRC, a high risk area and where 20% of the country's cobalt is extracted by artisanal mines, where serious, systemic human rights violations are commonplace, including child labour. For further detail see footnote 23 Bookmark not defined.

⁴¹ As an example see Groupe Renault and EEM create first "smart island" in Porto Santo. Accessed at: <https://media.group.renault.com/global/en-gb/groupe-renault/media/presreleases/21204577/le-groupe-renault-et-eem-creent-la-premiere-ile-intelligente-a-porto-santo>.

⁴² <https://www.bmw.cc/en/all-models/bmw-i/i3/2016/sustainability.html>.

Unless new solutions are found to decouple hard-to-abate transport growth from the resultant emissions, there is a risk that not only will transport emissions misalign with a 1.5°C or 2°C scenario, but they will continue to trend significantly higher and leave the world on track for a meaningfully higher temperature scenario:

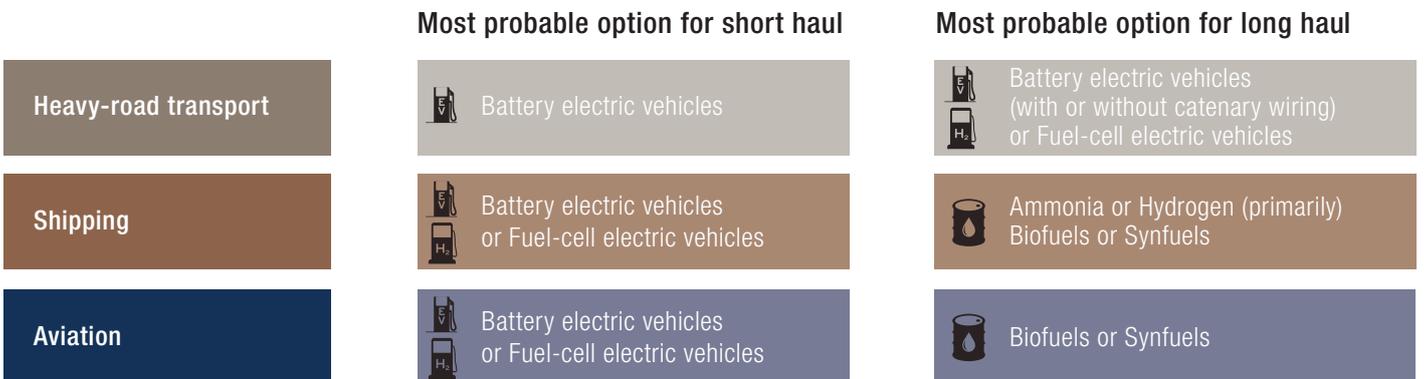
FIG. 17 EMISSIONS FROM LONG-HAUL AND HEAVY-DUTY TRANSPORT ARE ON TRACK TO ALMOST DOUBLE BY 2050, IF SOLUTIONS ARE NOT URGENTLY FOUND TO DECOUPLE DEMAND GROWTH FROM EMISSIONS



Source: IEA 2017, Energy Technology Perspectives.

Short-haul, heavy-transport can largely be electrified. However, long-haul travel is comparatively hard-to-decarbonise via electrification, primarily owing to current limits on battery weight and capacity.

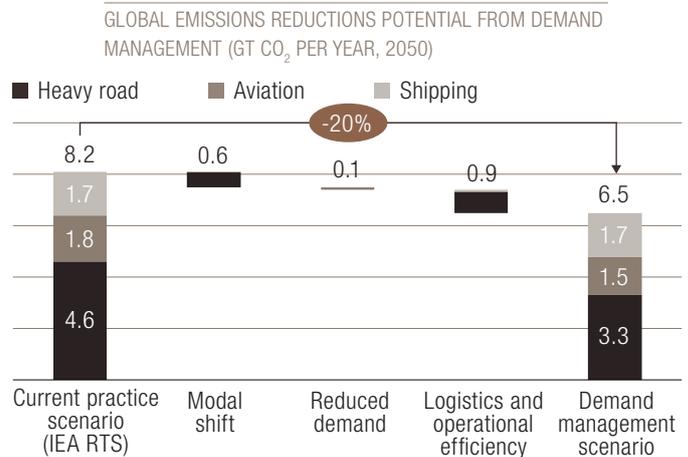
FIG. 18 ELECTRIFICATION IS LARGELY SUFFICIENT FOR SHORT-HAUL TRANSPORT BUT FOR LONGER TRIPS, ALTERNATIVE TECHNOLOGIES ARE REQUIRED TO DECARBONISE



Source: ETC Mission Possible 2018. For illustrative purposes only.

For these harder-to-abate, long-haul transportation sectors, once the low-hanging fruit of logistical and operational efficiencies are exhausted, we expect companies to face disruption as significant as that currently experienced by the automotive sector. To date, the freight sector has been less heavily regulated than the automotive sector. Demand-side management offers solutions both for cost-optimisation for freight operators and for decarbonisation but only c20% of emissions from hard-to-abate transport can be reduced by such measures. With increasing demand pressures on freight transport and air travel, much more needs to be achieved:

FIG. 19 DEMAND-SIDE MANAGEMENT CAN REDUCE 2050 EMISSIONS IN HARD-TO-ABATE TRANSPORT SECTORS BY C20% BUT MORE NEEDS TO BE ACHIEVED TO REACH NET-ZERO



Source: SYSTEMIQ analysis for the Energy Transitions Commission (2018).

Once efficiency optimisation and electrification of short-distance transport have been exhausted, alternative energy sources such as hydrogen, synfuels and sustainable biofuels are the only possible solutions for many long-distance trips. Many of these solutions are not yet commercially viable and require **significant infrastructure and technology advancement** to bring to market. We expect regulatory support to increasingly drive higher investment into less carbon-intense biofuels or “synfuels,”⁴³ with biomass and hydrogen likely to be among the key beneficiaries. We would, however, note a degree of caution on biomass (given scarcity and prioritisation needed for aviation and plastics). For **hydrogen**, we see a role for **heavy-duty road transport and rail**, but less role for light-duty vehicles, given the growing competitiveness of BEVs. However, where countries (such as Japan and Korea) have proactive hydrogen policies, there might be a stronger hydrogen path for light vehicle systems.

Abatement costs of long-haul transport are substantially higher than for short-haul, given many of these technologies are in their infancy, and targets to reduce emissions therefore pose a substantial financial challenge to companies operating in these industries, as well as risks of increased prices for end customers.

Rail is a comparatively emissions-efficient way of transporting freight and can reduce GHGs by up to 75% compared to trucks.⁴⁴ Rail currently accounts for less than 1% of global emissions. China's Belt and Road Initiative (BRI) includes creating a vast network of railways to connect the East and West via a “New Silk

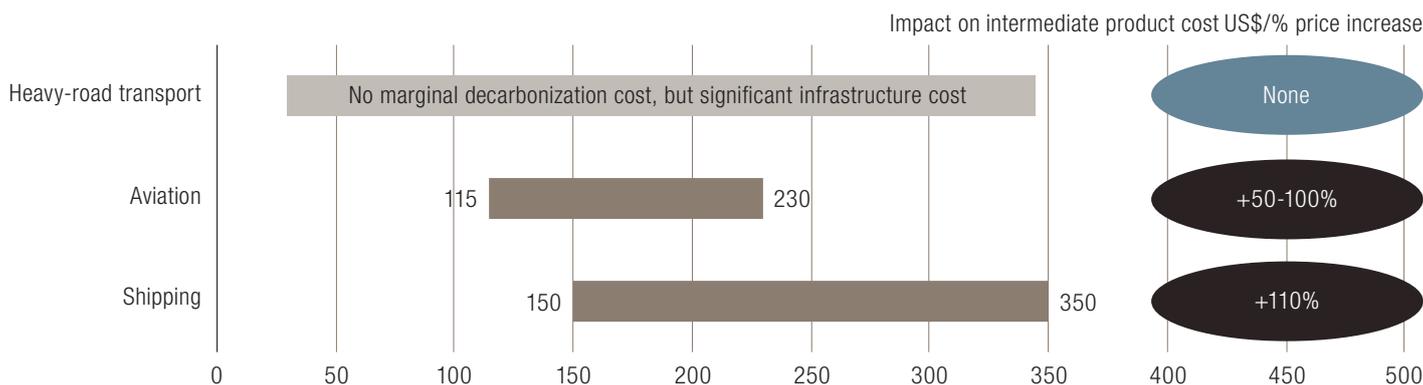
Road.” There is some controversy around the debt implications of the massive infrastructure spending initiative but China stresses it is to enhance regional connectivity. Certainly any switch in mode to increase rail usage is generally viewed as helpful for environmental purposes.⁴⁵

The EU in its proposed Taxonomy of sustainable activities, classifies rail activities as sustainable as it is perceived to be more sustainable compared to other modes of transport. Railway investments already represent a large share of climate-aligned bonds. 90% of all climate-aligned bonds within transport in 2017 were dedicated to railway projects, amounting to USD 481 billion.⁴⁶ But there is still a need to ensure rail is zero-emissions and phase out diesel trains and ensure a sustainable source of electricity for electric/hydrogen trains.

Hydrogen trains are already running – in Europe, Alstom has hydrogen-powered Coradia iLint trains running in Germany on a commuter rail line, with plans to run trains in France and the UK.⁴⁷ The first zero-emission “hydrail” project in the US will be in southern California, where the San Bernardino County Transportation Authority plans to operate a FLIRT H2 train from Swiss supplier Stadler from 2024.⁴⁸ **Hydrogen heavy-duty trucks** are soon to hit the roads: Hyundai's hydrogen-fuel-cell-powered, heavy-duty trucks will be available in Switzerland in 2020 as part of an order for 1,600 trucks that will be delivered between January 2020 and 2025.⁴⁹ Nikola Motors, based in the US, has seen at least

FIG. 20 DEMAND-SIDE

SUPPLY-SIDE ABATEMENT COST IN LOW-COST AND HIGH-COST SCENARIOS (USD/TONNE CO₂)



Source: SYSTEMIQ and UMAS analysis for the Energy Transitions Commission (2018).

⁴³ Synthetic fuels produced from coal, natural gas or biomass feedstocks through chemical conversion. In this scenario we are focusing on the ‘green’ or renewable sources for the Synfuel.

⁴⁴ <https://www.aar.org/issue/freight-rail-and-the-environment/>.

⁴⁵ <https://www.businessinsider.com/what-is-belt-and-road-china-infrastructure-project-2018-1?r=US&IR=T>.

⁴⁶ https://ec.europa.eu/transport/modes/rail/studies/development-methodology-assess-green-impacts-investment-rail-sector_en.

⁴⁷ Alstom (2018). Coradia iLint – the world's 1st hydrogen powered train. Accessed at: <https://www.alstom.com/our-solutions/rolling-stock/coradia-iiint-worlds-1st-hydrogen-powered-train>.

⁴⁸ Forbes (2019). Heavy-Duty Hydrogen: Fuel Cell Trains And Trucks Power Up For The 2020s. Accessed at: <https://www.forbes.com/sites/alanohnsman/2020/12/29/heavy-duty-hydrogen-fuel-cell-trains-and-trucks-power-up-for-the-2020s/#429a593d260c>.

⁴⁹ Reuters (2020). Powered by hydrogen, Hyundai's trucks aim to conquer the Swiss Alps. Accessed at: <https://www.reuters.com/article/us-hyundai-hydrogen-trucks/powered-by-hydrogen-hyundais-trucks-aim-to-conquer-the-swiss-alps-idUSKCN20M0Z9>.

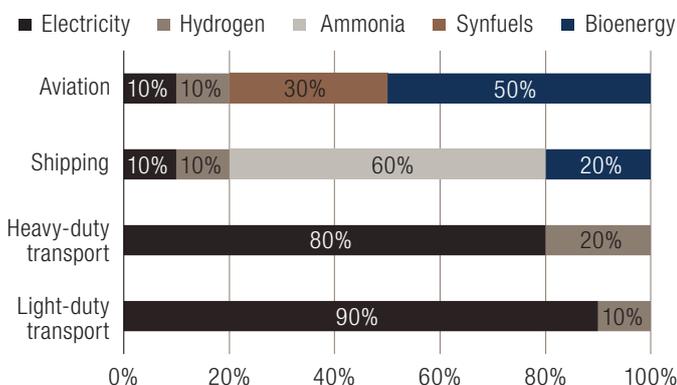
14,000 orders. Brewing company Anheuser Busch has a booking for 800 Class 8 trucks.⁵⁰ According to multiple industry journals,⁵¹ the Class 8 truck is expected to retail for USD 375k when it goes into production in 2022, compared with USD 180k for the all-electric Tesla Semi with a 500-mile range. Since 2018, Shell has been part of a Californian consortium to develop three new large-capacity refuelling stations for heavy-duty hydrogen fuel-cell trucks being developed by Toyota and Kenworth Truck Company.⁵²

For **aviation** we expect the use of sustainable fuels to increase rapidly from a low base – sustainable aviation fuel today accounts for just 0.1% of the overall market⁵³ – but we expect its availability to increase over the next few years.

Shipping is hard to decarbonise, with long asset cycles and high costs to decarbonise (estimates vary from USD 150-350/tonne CO₂⁵⁴), and the industry is more fragmented than aviation. Maersk has set the goal of reaching carbon neutrality in its own operations (Scope 1) by 2050⁵⁵ but says this can only be achieved via carbon-neutral fuels. Teekay Shuttle Tankers issued a Green Bond in 2019 with use of proceeds partly towards the delivery of e-vessels.⁵⁶

FIG. 21 ELECTRIFICATION IS LARGELY SUFFICIENT FOR SHORT-HAUL TRANSPORT BUT FOR LONGER TRIPS, ALTERNATIVE TECHNOLOGIES ARE REQUIRED TO DECARBONISE

FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN A NET-ZERO-CO₂-EMISSIONS ECONOMY, 2050 (%)

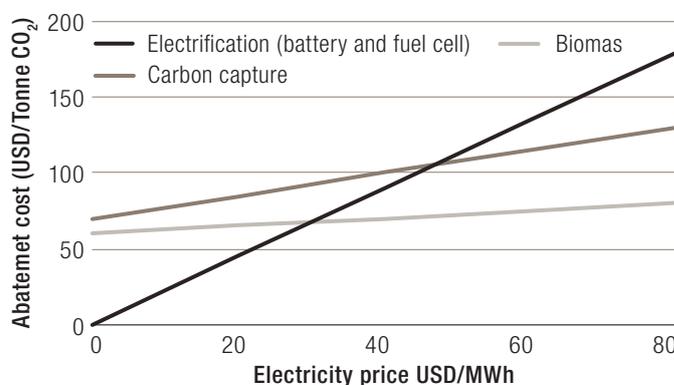


Source: ETC Mission Possible 2018.

Hydrogen is one of the most promising technologies to help decarbonise. There are currently no **ammonia**-fuelled ships in operation but the equivalent of about 3.5 million tonnes a year is traded using ships, according to the IEA. Earlier this year Equinor⁵⁷ signed an agreement with Eidesvik Offshore for the modification of the Viking Energy supply vessel to make it capable of covering long distances fuelled by ammonia. The five-year contract will see the vessel act as part of a research project with carbon-free ammonia fuel cells tested on the vessel from 2024.

Rail provides a significant growth opportunity for freight transport, in our view. It is relatively easy and cost-effective to decarbonise compared to long-haul shipping and aviation. China's Belt and Road Initiative (BRI)⁵⁸ is an example of a global infrastructure investment plan focused on improving international freight links by sea and rail. A China-Europe freight train service was first launched in 2011 and has since grown rapidly, allowing travel of 12,000km in 17 days. In 2019 a new rail route was inaugurated connecting China to Europe and the number of freight trains between Zhengzhou and the EU doubled in the first half of 2019, along the “New Silk Road.”

FIG. 22 ELECTRICITY VERSUS CCS ABATEMENT COST FOR LONG-HAUL TRANSPORTATION (HEAVY-DUTY ROAD, AVIATION AND SHIPPING)



Source: McKinsey 2018, Decarbonization of the industrial sectors: The next frontier.⁵⁹

⁵⁰ Forbes (2019). Nikola CEO Trevor Milton Is Now A Billionaire Thanks To Hydrogen Truck Startup's Fundraising Drive. Accessed at: <https://www.forbes.com/sites/alanohnsman/2019/09/04/nikola-ceo-trevor-milton-is-now-a-billionaire-thanks-to-hydrogen-truck-startups-fundraising-drive/#e2a1e485b0f5>.

⁵¹ <https://www.computerworld.com/article/3084546/nikola-motor-gets-23b-worth-of-preorders-for-electric-semi-trailer-truck.html>; <https://www.thedrive.com/news/3461/2-000-hp-hybrid-electric-nikola-one-semi-is-a-truckers-dream>; <http://www.trucktrend.com/news/1605-nikola-motor-company-shows-3700-lb-ft-class-8-hybrid-prototype/>; <https://www.commercialmotor.com/news/buying-advice/closer-look-hydrogen-fuelled-trucks>.

⁵² Shell (2020). Hydrogen Fuel. Accessed at: <https://www.shell.com/energy-and-innovation/new-energies/hydrogen.html>.

⁵³ International Energy Agency (2019). Are aviation biofuels ready for take off? Accessed at <https://www.iea.org/commentaries/are-aviation-biofuels-ready-for-take-off>.

⁵⁴ Energy Transitions Commission, *Mission Possible* (November 2018). Accessed at: http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_FullReport.pdf.

⁵⁵ <https://www.maersk.com/news/articles/2019/03/27/decarbonising-logistics>.

⁵⁶ <https://www.teekay.com/wp-content/uploads/2019/10/Teekay-Shuttle-Tankers-L.L.C.-Green-Bond-Investor-Presentation.pdf>.

⁵⁷ Equinor (2020). The world's first carbon-free ammonia-fuelled supply vessel on the drawing board. Accessed: <https://www.equinor.com/en/news/2020-01-23-viking-energy.html>.

⁵⁸ <https://www.businessinsider.com/what-is-belt-and-road-china-infrastructure-project-2018-1?r=US&IR=T>.

⁵⁹ Accessed at <https://www.mckinsey.com/~media/mckinsey/business%20functions/sustainability/our%20insights/how%20industry%20can%20move%20toward%20a%20low%20carbon%20future/decarbonization-of-industrial-sectors-the-next-frontier.ashx>.

For further detail on the sustainability of hydrogen, please see our whitepaper Investing in the [Climate Transition](#).

A tipping point in terms of CO₂ abatement cost for electrification (battery electric or fuel-cell electric), biomass and carbon capture depends heavily on electricity price (see Figure 21).

It is also worth noting that no sector should over-rely on carbon capture and abatement measures. In order to reach a net-zero pathway, there are certain sectors which will be impossible to fully decarbonise (as per Figure 6) and these sectors will rely on the

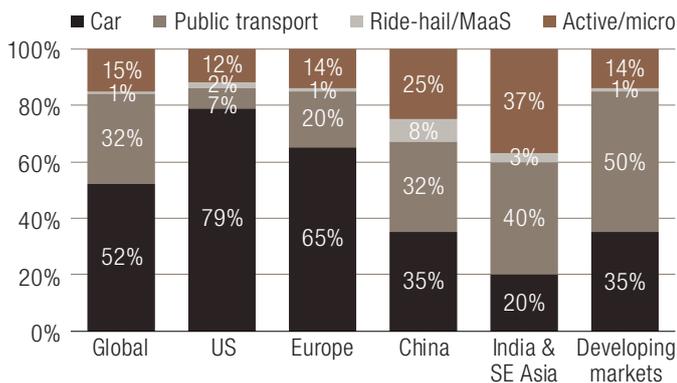
net-negative emissions from land-use, agriculture, forestry and biomass. However, there is not enough land to go round, or biomass to use (without degrading our nature’s biodiversity even more) to offset all such emissions and therefore new technology solutions will be required for long-haul transport.

Those companies that do not shy away from this disruption and invest in potential solutions to decarbonise transportation, will be best placed to deliver value for investors.

3. Lockdown reduces transport usage and drives clearer skies

The COVID-19 crisis has driven a dramatic drop in all transportation as many countries have imposed restrictions to public movement. In many cities, for the first time in years, roads are traffic-free and air pollution has fallen more than 50%.⁶⁰ The TomTom traffic index⁶¹ showed that in 2019, the average person spent an extra 87 minutes in traffic than in 2018 but in 2020, cities with COVID-induced travel restrictions have seen congestion drop by up to 85%. Air travel has fallen close to 90% in many regions. Travel restrictions have impacted freight and hurt global supply chains. Will this continue once lockdowns are lifted?

FIG. 23 PERSONAL TRANSPORT MODE (AS A % OF TOTAL TRIPS) DIFFERS GEOGRAPHICALLY BUT THE CAR DOMINATES IN DEVELOPED MARKETS



Source: LOIM estimates, National Statistics, US National Household Transport Survey (2017).

3.1. Short-haul mobility is too car-centric

Prior to the devastating COVID-19 crisis, short-haul travel was already beginning to shift away from its "WILD" model and transition to "CLIC" (see section 2.1 above). However, this was not happening with sufficient urgency to hit air pollution and net-zero targets. Despite global regulations aiming to discourage personal car usage – such as low-emissions zones, congestion charging, parking restrictions and bans on older cars in multiple cities – urban air quality and congestion were continuing to deteriorate. In China, the State Council has decreed that megacity air quality represents not just a threat to public health (the WHO estimated that outdoor air pollution caused 4.2 million premature deaths in 2016⁶²) but also to civil order. A study across the US, UK, France and Germany showed that congestion on our roads is costing the economy on average almost 1% of GDP and harming health due to worsening air pollution⁶³ and yet pre-COVID, 80% of all mileage in the US was by car and c.50% globally.

Many local governments were initiating ICE restrictions in city centres long before the COVID-19 crisis. For instance, Oslo has closed off certain streets to cars and removed almost all parking spaces to replace with cycle lanes and green spaces.⁶⁴ Mexico and many other Latin American countries have initiated the "pico y placa" initiative, where the right to drive depends on your licences plate.⁶⁵ Many Chinese cities have similarly restrictive schemes. Singapore has punitively high taxation on the car to discourage usage. In Paris there are plans to remove 60,000 car parking spaces, or 72% of the total on-street parking. The Paris Mayor announced in January she wants all Parisian streets to be cycle-friendly by 2024, with plans for a "city of fifteen minutes"⁶⁶ (for further detail see section 4.5 below).

⁶⁰ <https://www.wsj.com/articles/coronavirus-got-rid-of-smog-can-electric-cars-do-so-permanently-11586532988?mod=e2tw>.

⁶¹ https://www.tomtom.com/en_gb/traffic-index/.

⁶² WHO (2019). The public health challenge of air pollution – a WHO perspective. Accessed at: <https://www.unsdsn-ne.org/wp-content/uploads/2019/09/WHO-ECEH-Gothernburg-fin-2.pdf>.

⁶³ United Nations, *Mobilising Sustainable Transport for Development*: <https://sustainabledevelopment.un.org/content/documents/2375Mobilizing%20Sustainable%20Transport.pdf>.

⁶⁴ BBC (2019). What happens when a city bans cars from its streets? Accessed at: <https://www.bbc.com/future/article/20191011-what-happens-when-a-city-bans-car-from-its-streets>.

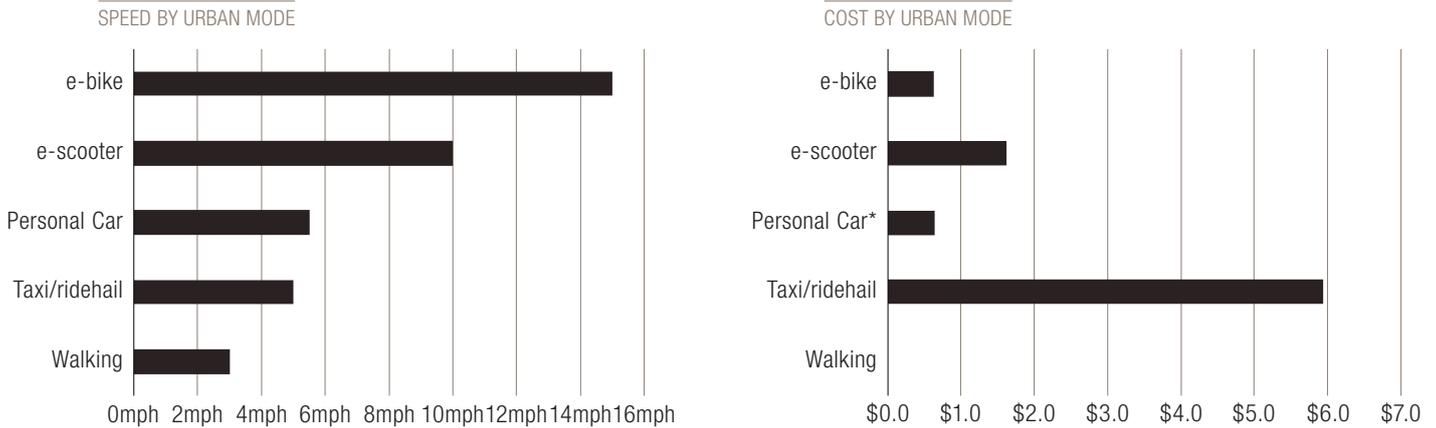
⁶⁵ BBC Autos (2014). The successful anti-gridlock scheme of Colombia. Accessed at: <http://www.bbc.com/autos/story/20130123-colombias-anti-gridlock-scheme>.

⁶⁶ Forbes (2020). Every street in Paris to be cycle-friendly by 2024, promises Mayor. Accessed at: <https://www.forbes.com/sites/cartonreid/2020/01/21/phasing-out-cars-key-to-paris-mayors-plans-for-15-minute-city/#2b9a384e6952>.

And yet pre-COVID, global traffic data showed congestion was growing dramatically each year, worsened by the growing popularity of online deliveries and ridehail. Average road speed in many city centres was as low as 5-6mph, which helped to spur the advent of micromobility (small, shared electric 2 and 3-wheel vehicles), since electric scooters and bikes can reach much higher average speeds (see Figure 23):

But despite higher cost and pollution effects, and slower speeds in congested urban areas, the convenience of the personal car makes it the predominant mode of transport in most developed markets (see Figure 24):

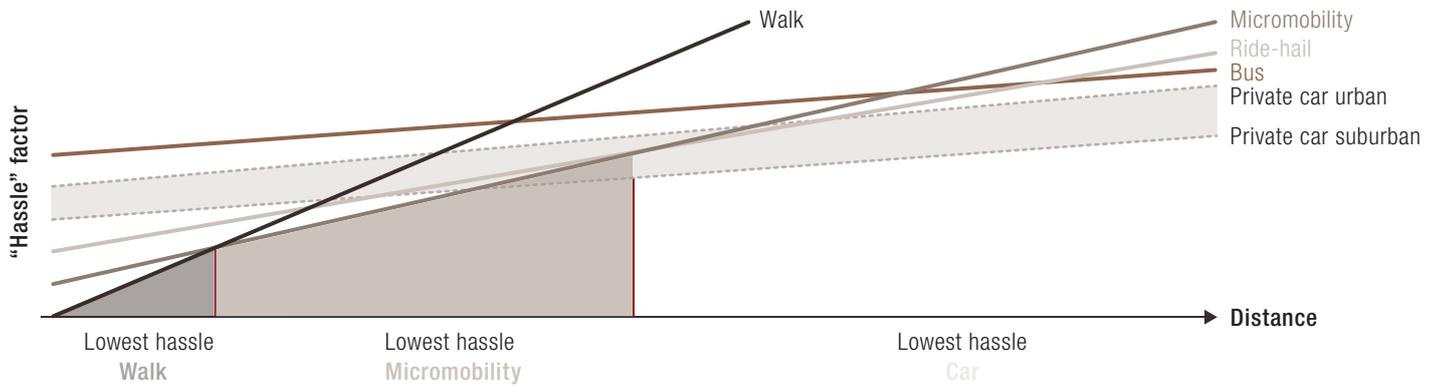
FIG. 24 SPEED VERSUS COST/MILE IN URBAN LOCATIONS SUPPORTS THE UPTAKE OF ACTIVE AND MICRO MOBILITY



Source: LOIM, National Statistics. Note: data for 2019 in major US metropolitan regions.

* Note: The cost/mile depends on monthly mileage and could cost +USD11/mile for low mileage vehicles, as we will discuss at Figure 30.

FIG. 25 OVER MEDIUM DISTANCES, DESPITE HIGHER COST, THE PERSONAL CAR HAS THE LOWEST “HASSLE FACTOR” (A COMBINATION OF SPEED, DISTANCE TO DROP OFF AND COST)



Source: LOIM. Walk <1 mile; Micromobility >500m; Car >2-5 miles.

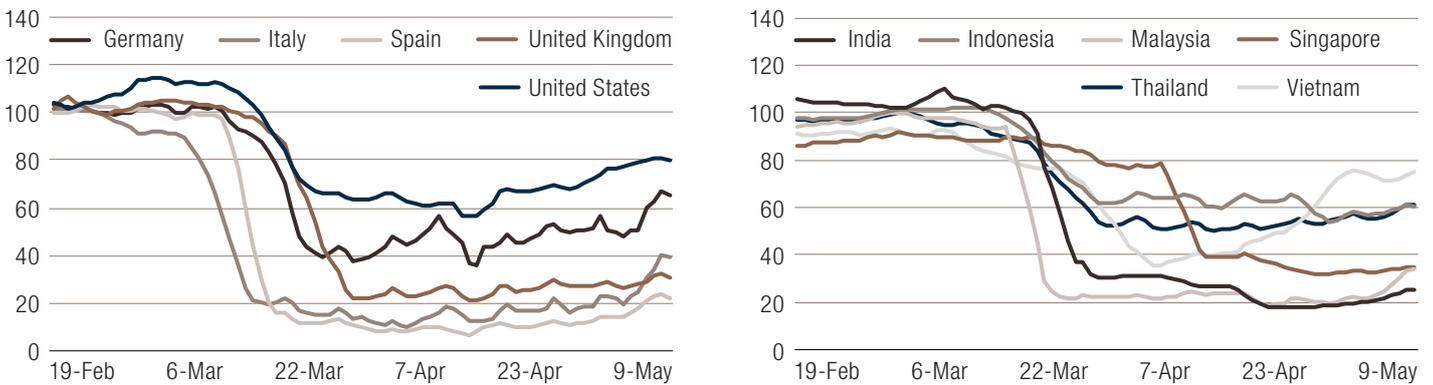
3.2. Has the drop-off in mobility during lockdown shifted this car-centric model?

What has been the impact of lockdown on city streets? Traffic-free roads, greater space and safety for pedestrians and cyclists and of course, clearer air.

Data from Google⁶⁷ captures the percentage change in activity at retail and recreation locations over the last few months in different regions globally, which we have taken as a proxy for personal mobility compared to pre-lockdown levels. It shows how dramatically footfall fell and why roads and transport systems were significantly emptier. However, it also shows a trend upwards again as lockdowns begin to ease:

⁶⁷ Google Mobility data utilises Google’s location history data that measures number of visits to and duration of visit at a given location, and it takes the median value observed during the period 3 January 2020 – 6 February 2020 as its baseline comparison level. Accessed at: <https://www.google.com/COVID19/mobility/>.

FIG. 26 GOOGLE MOBILITY DATA SHOWING % CHANGE IN RETAIL AND RECREATION ACTIVITY FOR GIVEN REGIONS GLOBALLY (START VALUE = 03/01/2020-06/02/2020 MEDIAN = 100)



Source: Google opensource.

The auto industry has been hit hard by lockdowns with sales volumes grinding to a halt in many countries. To put this in context, in the UK, a country proposing the ban of all combustion engine car sales by 2035,⁶⁸ latest figures show **new car sales fell 97% during lockdown** with combustion engine sales of just 2,600 in April 2020, down from 146,000 in the same month last year. By contrast BEV sales fell a comparatively smaller 10%.⁶⁹ There were regional variances in EV performance during lockdowns with EV demand in China falling in line with ICE demand in the first three months of the year, but in key European markets, such as Germany and the UK, EV demand was up triple digits in March (potentially due to delivery of pre-lockdown orders) whilst ICE sales collapsed by 50%.⁷⁰

In the EU the automotive supply chain comprises 6% of all employment, the industry is vital to the future economy. However, any recovery package to support the industry must also take into account the urgent need to decarbonise. Bloomberg New Energy Finance⁷¹ forecasts that EV sales will fall 18% globally in 2020 but that long-term prospects remain undimmed. We will discuss in section 4 the risk that pressure on public transportation will drive a resurgence in personal car usage post-lockdowns but remain confident that the shift to electric mobility will continue unabated.

3.3. Air pollution linked to both COVID-19 transmission and transport usage

Research⁷² is now linking exposure to pollution with the spread and mortality rate of COVID-19, through the effect of air pollution on the body's immune response and on underlying, aggravating

health conditions. A review of the causes and contributing factors of the crisis may reinvigorate efforts to tighten emission controls, especially in transport, given the bluer skies that have been experienced as a result of travel-restrictions due to the pandemic.

Urban pollution was already in focus pre-COVID. The OECD estimates that road transport contributes up to 30% of Particulate Matter (PM) in European cities and up to 50% of PM across OECD countries.⁷³ More than 250 European cities have introduced Low-Emission Zones (LEZ). LEZs have helped cut NO₂ levels significantly. A paper by the Transport & Environment group found that NO₂ levels fell by 32% in Madrid after a LEZ was implemented. London, which introduced the world's first Ultra Low Emission Zone (ULEZ) in 2019, has cut the number of NO₂ pollution breaches by 97% since 2016. However, LEZs rarely ban outright less efficient vehicles, and usually impose charges for the entry of such vehicles, thus enabling logistics and freight transit, which often utilise older, diesel vehicles through urban areas. But the growth in online deliveries and ridehail, as well as accelerating urbanisation are all contributing to rising transport demands.

We therefore expect large urban centres to intensify restrictive measures for ICE vehicles post COVID-19, supporting recent proposals from some EU countries such as the UK, France, Denmark, Sweden, Netherlands, Ireland and others, to fully phase out oil-fuelled vehicles between 2025 and 2040, though no specific date has been approved by the EU so far in the face of opposition to a phase-out date from some EU members from central and eastern Europe.

⁶⁸ <https://www.bbc.com/news/science-environment-51366123>.

⁶⁹ <https://www.smmr.co.uk/vehicle-data/car-registrations/>.

⁷⁰ Bloomberg New Energy Finance.

⁷¹ BNEF Electric Vehicle Outlook 2020, 19 May 2020.

⁷² <https://projects.iq.harvard.edu/COVID-pm>.

⁷³ <https://www.smartcitiesworld.net/special-reports/special-reports/the-war-on-smog->

Some cities were also experimenting with car-rationing to cut back on pollution. In November 2019, local authorities of New Delhi launched an emergency “car rationing” system in a bid to curb pollution levels. Over the course of two weeks the city alternated between allowing cars with even or odd licence plates to enter the capital. The city has used this measure before, back in 2015 and in 2017. Academics from the University of Chicago and Harvard University estimate that PM2.5 levels dropped by 13% during the 2015 “odd-even” scheme. Many cities in China have similar driving restrictions.

During the COVID-19 lockdowns, pollution dropped more drastically. With so many commuters working at home and leisure trips curtailed, recent analysis by the UK Centre for Ecology and Hydrology and the University of Reading calculated an overall 58% drop in atmospheric emissions in central London since March 23.⁷⁴ While it is hard to calculate the proportion of pollution that relates to traffic versus other emissions sources, such as gas boilers for building heating, the drop in carbon dioxide emissions closely mirrors the daily reduction of 60% in traffic in central London which Transport for London recorded during the first five weeks of the UK’s lockdown.⁷⁵

According to the Royal Netherlands Meteorological Institute (KNM), major cities in Spain, Italy and France have been experiencing a c.45% drop in nitrogen dioxide levels since the start of the COVID-19 outbreak due to the introduction of strict lockdown measures that have resulted in a sharp fall in vehicle traffic.

Satellite images revealed dramatic reductions in concentrations of pollutant nitrogen dioxide in China and northern Italy, coinciding with lockdowns to tackle the coronavirus pandemic.

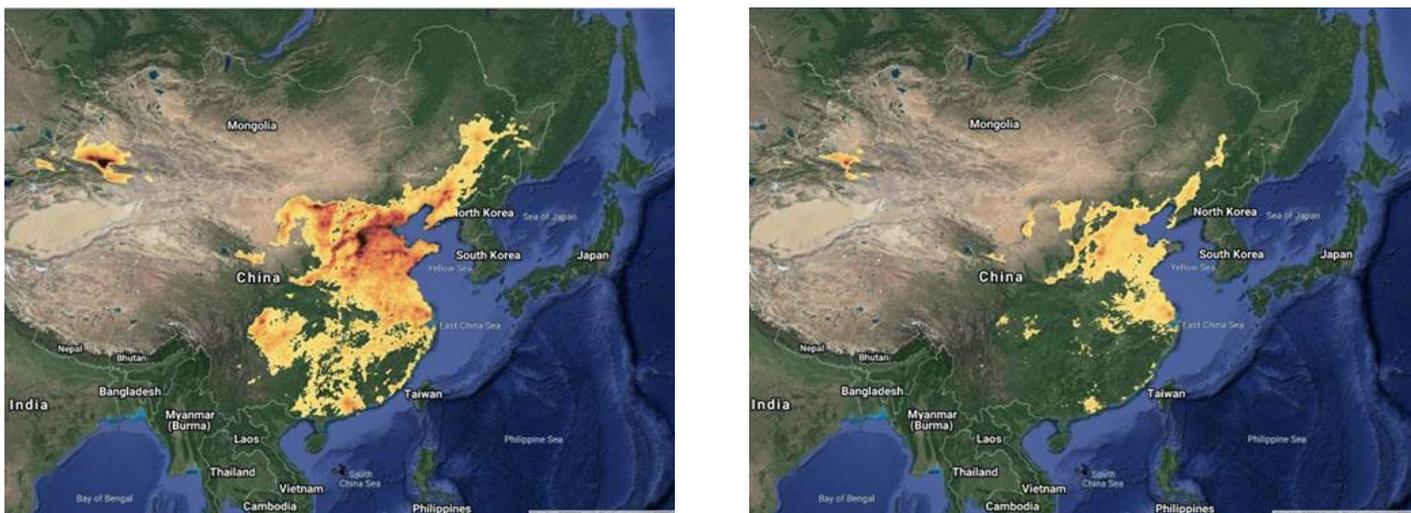
Are these cleaner skies here to stay or will they revert immediately once economic and industrial activity re-starts? Latest data from China implies a pick up in industrial activity and transport can lead to a fast recovery in pollution.⁷⁶

3.4. Transport modal shift: Soft mobility rises as public transport falls

Travel constraints during the pandemic varied by geography in terms of start-date, duration and restrictiveness and also led to different shifts in transport mode. **In China**, during the lockdown period in February, 27 Chinese provinces and 428 cities suspended transit completely. However, in some regions, bus operators introduced new, on-demand shuttle bus lines during the outbreak to run in addition to fixed-route services and help essential workers get to their jobs. Powered by mobile apps, these lines were developed specifically to serve new commuting patterns. By the end of March, the Beijing Public Transport Group had opened 173 customized routes.⁷⁷

While **public transport ground to a halt**, dockless bike sharing rose sharply in China. In Wuhan, where public transport was shutdown entirely during the lockdown,⁷⁸ key workers were only able to utilise shared bike schemes to travel to work. During

FIG. 27 SATELLITE IMAGERY OVER CHINA SHOWS THE REDUCTION IN POLLUTION PRE AND DURING LOCKDOWNS (AS MEASURED BY THE MEAN OF NO₂ CONCENTRATIONS DURING SPECIFIC PERIODS)



Source: © Produced from ESA remote sensing data (Sentinel 5P), images processed by Lombard Odier. Data as per 1/1/20-20/1/2020 (left image) and 1/2/2020-20/2/2020 (right image). For illustrative purposes only.

⁷⁴ <https://www.energyvoice.com/other-news/240936/londons-carbon-emissions-plummet-by-60-during-lockdown-analysis-finds/>.

⁷⁵ idem.

⁷⁶ <https://www.cbsnews.com/news/coronavirus-china-lockdown-over-air-pollution-already-spiking-industry-dirty-economic-rebound/>.

⁷⁷ <https://thecityfix.com/blog/3-ways-chinas-transport-sector-working-recover-COVID-19-lockdowns/>.

⁷⁸ BBC, *Coronavirus: Wuhan shuts public transport over outbreak, 23 January 2020* <https://www.bbc.com/news/world-asia-china-51215348>.

the 50-day public transport lockdown in Wuhan, Meituan Bike (formerly Mobike) provided 2.3 million trips in the city. Data shows cyclists in China rode longer distances and directly to their final destinations, not just for first- and last-mile connections. Beijing cyclers now average 2.4 kilometers per ride, a 69% increase from pre-pandemic. Hello-Bike data also suggests that at the country level, long distance rides (more than 3 kilometers) have almost doubled compared to last year.⁷⁹

Other **global cities shut down bike-sharing and micromobility schemes** and kept public transport operating. For instance, in the US, micromobility operator, Lime's CEO recently stated that due to COVID-19, Lime had to pause operations in 99% of its markets worldwide to support cities' efforts at social distancing.⁸⁰ Other micromobility operators chose to continue and offer free rides to healthcare workers, such as Revel's e-moped service in New York.

Many cities globally have had to contend with **severely reduced demand for all forms of public transport** and it is unclear how quickly this demand will recover, with many commuters likely to distrust the health implications of crowded, shared transport for some time to come. **Ridehail** has also come under pressure, with spending in the US on Uber's rides dropping 83% in March,⁸¹ even as food delivery demand soared.

Many businesses have drastically shifted their business models to deal with the crisis – with Honda converting vehicles to transport patients,⁸² US ride-hail operator Lyft helping with the delivery of essential items,⁸³ London-based taxi service Addison Lee partnering with coach platform Zeelo to provide transport and logistics to support healthcare.⁸⁴ Many commuters have also had to shift their transport mode, depending on availability and new styles of working, which in some instances has led to a greater uptake of **MaaS (mobility as a service)**, given the need for more flexibility in transport mode.

There has been a comparative surge in **online shopping and food delivery** in recent weeks – Barclays Research⁸⁵ found that offline spend in the UK fell 55% YoY in April 2020 while online spend remained flat. While more than half of UK card spending was

online even before this year, this has jumped to over 70% since the COVID-19 epidemic took hold. If this relative growth continues as lockdowns ease, we will see increasing pressure on delivery fleets to decarbonise. Some are already doing so, for instance Amazon announced last year it will add 100,000 electric vehicles to its fleet in order to cut emissions.⁸⁶

As we will discuss in section 4, **it is vital to ensure that as transport starts to resume, any new habits formed, for either goods or personal transport, will help support the transition to a CLIC mobility model.**

3.5. Travel and tourism grinds to a halt

The UN World Tourism Organization counted 1.4 billion international tourist arrivals in 2018,⁸⁷ and, well before the crisis, had predicted 1.8 billion arrivals by 2030.⁸⁸ More than 10% of the global workforce is employed by the tourism industry,⁸⁹ and millions of people rely on business generated by travellers. But with virtually all long-distance travel halted, the way we move is likely to undergo a dramatic transformation.

In China, the civil aviation market dropped by around 80% between January 23 and the middle of March, according to IATA figures. Nearly 500,000 domestic and international flights to and from China were cancelled.⁹⁰ China aviation is a critical link in the global just-in-time manufacturing process and therefore this travel disruption has heavily impacted global supply chains (as we will discuss in section 3.7).

IATA estimates COVID-19 has put over half of 2020 passenger air revenues at risk, with lost revenues of USD 314 billion in 2020 or -55% versus 2019.⁹¹ Global passenger traffic, measured in Revenue Passenger Kilometres (RPKs), was down 52.9% year-on-year in March, the largest decline in recent history.⁹² Available Seat Kilometres (ASKs) contracted by 36.2% in March, leading to the global load factors declining by 21.4% to 60.6%. By May, flights in Europe had decreased 90% year-on-year and EUROCONTROL predicts that flights statistics could still be down 25% in nine months time.⁹³

⁷⁹ Idem.

⁸⁰ <https://www.li.me/second-street/limes-path-through-COVID-19>.

⁸¹ <https://www.nytimes.com/2020/04/17/technology/uber-lift-coronavirus.html>.

⁸² <https://www.thedrive.com/tech/33052/how-honda-is-transforming-the-odyssey-minivan-to-transport-COVID-19-patients>.

⁸³ CNN, *Lyft is tapping more drivers to help with delivery of essential items*, 15 April 2020. Accessed at: <https://edition.cnn.com/2020/04/15/tech/lyft-essential-deliveries/index.html>.

⁸⁴ <https://www.fleetnews.co.uk/news/car-industry-news/2020/04/15/addison-lee-and-zeelo-offer-transport-services-to-london-s-hospitals-and-healthcare-workers>.

⁸⁵ Barclays Research, *Investment Sciences: Spend Trends 2.0 in lockdown* (13/5/20).

⁸⁶ <https://www.wsj.com/articles/amazon-to-add-100-000-electric-vehicles-as-part-of-climate-pledge-11568914649>.

⁸⁷ UNWTO (2019). International tourists arrivals reach 1.4 billion two years ahead of forecasts. Accessed at: <https://www.unwto.org/global/press-release/2019-01-21/international-tourist-arrivals-reach-14-billion-two-years-ahead-forecasts>.

⁸⁸ UNWTO (2011). International tourists to hit 1.8 billion by 2030. Accessed at: <https://www.unwto.org/archive/global/press-release/2011-10-11/international-tourists-hit-18-billion-2030>.

⁸⁹ <https://skift.com/2016/03/27/the-travel-industry-now-supports-nearly-10-percent-of-worlds-jobs/>.

⁹⁰ https://www.airlines.iata.org/news/china%E2%80%99s-domestic-aviation-industry-showing-upward-trend?_ga=2.53434728.19187804.1589874397-451110438.1589874397.

⁹¹ <https://www.iata.org/en/pressroom/pr/2020-04-14-01/>.

⁹² <https://www.iata.org/en/iata-repository/publications/economic-reports/air-passenger-monthly-analysis---mar-2020/>.

⁹³ <https://www.eurocontrol.int/COVID19>.

Passenger air demand closely follows GDP progression and the longer travel restrictions are necessary, the deeper the recessionary impact is likely to be on demand for travel. Air travel is often blamed for rising global emissions but it is worth noting that it currently accounts for less than 3% of total global annual emissions, therefore a prolonged drop off in air travel will not have the truly dramatic impact on pollution and CO₂ as many may assume. We will discuss in section 4 how prolonged the decline may be and how impactful any shift in transport mode away from passenger air could be for sustainability metrics.

3.6. Freight transport was impacted heavily by lockdowns

Transport disruption has not been confined to personal transportation and local goods deliveries. Airlines transport over 52 million metric tons of goods a year, representing more than 35% of global trade by value but less than 1% of world trade by volume. That is equivalent to USD 6.8 trillion worth of goods annually, or USD 18.6 billion worth of goods every day.⁹⁴ Since the COVID-19 crisis began, air cargo has been delivering much-needed medicines, medical equipment (including spare parts/repair components), and keeping global supply chains functioning for the most time-sensitive materials.

But as the COVID-19 outbreak became a global pandemic, the **global demand for air cargo**⁹⁵ fell by 15.2% (this compares to -23% annual decline in 2008 during the Global Financial Crisis) and global capacity⁹⁶ shrank by 22.7% year-on-year in March 2020. This continues the longest period of decline in cargo demand (12 consecutive months) since the Global Financial Crisis. Only demand for pharmaceutical products (excluding medical equipment) continued to grow sharply.

COVID-19 containment policies have also heavily impacted **sea transport**. The departure of all ships in the first week of April 2020 was down 20% compared to 2019, while the decrease in container-ship departures was 29%, as a result of restrictions on

crew changes in many regions.⁹⁷ The **global freight rail** market has not been hit as hard and is forecast to decline only 2.5% in 2020.⁹⁸ An ongoing **shift toward rail freight** could help support sustainability goals, given carbon-abatement is easier here than for air or sea.

It has been estimated that a higher modal share of 30% of rail freight by 2030 could lead to a EUR 100 billion economic gain due to less externalities, 290 million tons of saved CO₂, 40,000 less premature deaths due to avoided pollution and 5,000 less fatalities due to saved truck accidents.⁹⁹

3.7. Supply chain disruption under COVID-19 could drive increased localisation

The decline in air and sea freight has **heavily disrupted global supply chains**. For instance, the automotive industry with its just-in-time supply chain and global supplier network felt the shock early on. However, supply and demand for EVs is now normalising in China and Volkswagen recently increased its stake in its joint venture partner in China.¹⁰⁰

Many occupations crucial to the safe and continued functioning of global supply chains rely on unhindered movement across both land and sea. Close to 90% of global trade is transported by sea, and the global ocean supply chain is responsible for the continued flow of food, fuel, medical supplies, raw materials and agricultural products.¹⁰¹ As transportation is an important vector of transmission, the sector was one of the first to face significant restrictions.¹⁰²

For example, travel restrictions and grounded airplanes have made the monthly changeover of 100,000 crew members in ships impossible, and April changeovers were postponed.¹⁰³ This has put tremendous pressure on global ocean supply chain. Labour shortage in key industries such as fisheries are posing a risk to key food supply¹⁰⁴ as it is difficult to get specialised personnel on board vessels and offshore energy platforms to undertake operations, maintenance, and repair.¹⁰⁵

⁹⁴ <https://www.iata.org/en/programs/cargo/>.

⁹⁵ In Cargo Tonne Kilometers (CTKs).

⁹⁶ In Available Cargo Tonne Kilometers (ACTKs).

⁹⁷ <https://voxeu.org/article/COVID-19-restrictions-hit-sea-transportation>.

⁹⁸ <https://www.railfreightforward.eu/>

⁹⁹ https://finance.yahoo.com/news/rail-freight-industry-outlook-2020-172400110.html?guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAI0ki2yxihCPLp2eeJ5D4FlnaTnOK7l8L3IDjvonhm942arQZT6K4lQfYcC1F8SXRLBz7-yM1PtTyZmUXntff1EhqVJBuyqEP1YU22CUW869VIE7Et4nPILXrFY3yhhM6wvdcmk9a8agN11ds_NoeyJ5oBLNDmOCh-XokTrWQ&guc_consent_skip=1589905675.

¹⁰⁰ <https://www.weforum.org/agenda/2020/02/how-coronavirus-disrupts-global-value-chains/>.

¹⁰¹ <https://www.weforum.org/agenda/2020/05/global-supply-chains-are-under-imminent-threat-from-the-COVID-19-pandemic/> and <https://www.ics-shipping.org/shipping-facts/shipping-and-world-trade>.

¹⁰² <https://voxeu.org/article/COVID-19-restrictions-hit-sea-transportation>.

¹⁰³ <https://www.weforum.org/agenda/2020/05/global-supply-chains-are-under-imminent-threat-from-the-COVID-19-pandemic/>.

¹⁰⁴ <http://www.fao.org/3/ca8637en/CA8637EN.pdf>.

¹⁰⁵ <https://www.weforum.org/agenda/2020/05/global-supply-chains-are-under-imminent-threat-from-the-COVID-19-pandemic/>.

Some governments like the **UK** are designating workers in the transport, food and energy sector as critical to ensure work continuity.¹⁰⁶ The **European Union** (EU) has set up guidelines on free movement for workers exercising critical occupations during the pandemic, including transport workers.¹⁰⁷ In order to preserve EU-wide operation of supply chains and ensure the functioning of the Single Market for goods, the EU has set up "green lane" border crossings enforcing checks and health screening of transport workers to not exceed 15 minutes for example.¹⁰⁸

In **China**, as in most parts of the world, trucks were key in delivering essential medical supplies and vital household goods in most affected provinces. However, the COVID-19 outbreak still decreased passenger traffic by 52.4% and road freight decreased by 24.8% year-on-year in January and February. To tackle such challenges, the Chinese authorities have implemented a "no-stop, no-check, toll-free" policy for vehicles transporting emergency supplies and essential personnel, as well as reduced cargo dues and port facilities fees by 20%.¹⁰⁹ This did not **prevent significant short-term disruption to the electric vehicle battery supply chain**, which has further impacted an industry already struggling with capacity shortages in Europe. Countries have worked together to ease these issues with, for instance, Poland easing its lockdown on air travel to allow Korean battery manufacturer LG Chem to send 200 engineers to its Polish gigafactory on a special flight.¹¹⁰

In the **US**, the Cybersecurity & Infrastructure Security Agency (CISA) has also issued guidelines to support State and local officials in

ensuring overall national resilience in COVID-19 response. Such guidelines include transportation and logistics workers.¹¹¹

But despite all these measures, multiple companies, including auto companies which rely on just-in-time inventory management and where the electric vehicle supply chain relies heavily on Asia for battery supply, experienced disruption to their global supply chains. As industry starts to recover, we expect to see an increased focus on supply chain resilience and adaptability. This may lead to a new focus on localisation, or at least more diversified supply chains and less reliance on specific markets for essential goods. It could also lead to a **surge in demand for technology to support better resilience** – particularly increased levels of automation and Industry 4.0 in manufacturing. Overall, companies will likely start to better understand (and disclose) risk competitiveness, rather than just focusing on the lowest cost procurement.

Given the vital importance of global supply chains, governments are investing heavily in infrastructure and technology to improve the efficiency, speed and resilience of cross-border transport. Improvements to the sustainability of freight, via integrate port terminals, greater rail connectivity, harmonised standards and regulations for efficient border crossings have been estimated to drive growth in global GDP of USD 2.6 trillion.¹¹²

This could present investable opportunities for companies focused on supply chain optimisation, robotisation, Artificial Intelligence, alternative modes of freight (such as rail) and more localised suppliers and delivery services.

¹⁰⁶ <https://www.gov.uk/government/publications/coronavirus-COVID-19-maintaining-educational-provision/.guidance-for-schools-colleges-and-local-authorities-on-maintaining-educational-provision#critical-workers>.

¹⁰⁷ [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020XC0330\(03\)#ntr8-Cl2020102EN.01001201-E0008](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020XC0330(03)#ntr8-Cl2020102EN.01001201-E0008).

¹⁰⁸ https://ec.europa.eu/transport/sites/transport/files/legislation/2020-03-23-communication-green-lanes_en.pdf.

¹⁰⁹ IRU (2020). China's 37 supporting measures to transport companies. Online: <https://www.iru.org/system/files/China%27s%2037%20supporting%20measures%20to%20transport%20companies.pdf>.

¹¹⁰ <https://insideevs.com/news/410551/lg-chem-200-engineers-poland-gigafactory-flight/>.

¹¹¹ <https://www.cisa.gov/sites/default/files/publications/CISA-Guidance-on-Essential-Critical-Infrastructure-Workers-1-20-508c.pdf>.

¹¹² *Mobilizing Sustainable Transport for Development*.

4. Could we see a shift in mobility mode post-lockdown?

Will countries and cities just return to normal once travel restrictions are eased? While we expect commuter figures to remain depressed for a prolonged period as employers and employees re-think remote working practices, as lockdowns ease, more and more commuters will return to city centres. It could be a **once-in-a-lifetime opportunity to rethink our city space**, away from roads and parking and towards **active mobility** and green space.

We expect to see significant shifts in transport mode. Short-term we could see a dramatic shift away from crowded, public transport options and towards personal mobility but we expect policymakers to react quickly to this risk and **discourage personal car usage** and encourage active and micromobility options instead. Over time, we expect to see a shift away from owned vehicle and towards mobility as a service (MaaS), from personal car to shared electric vehicle (micromobility, ridehail, microtransit, bus and rail) and from air and sea to zero-emission road and rail.

We expect to see a significant rise in **home-working** and for business travel to fail to recover to 2019 levels, hurt both by damage to the economy but also by new habits formed for remote-working and conferencing. Recovery for the tourism industry is hard to predict, as it depends heavily on time horizons for countries reopening borders without long quarantine restrictions. In the short-term, a surge in “staycations” could damage transport emissions trajectories, given shared aircraft emissions are lower than personal vehicle travel over long distances (particularly for larger vehicles such as caravans and RVs) but we do expect strong pent-up demand for foreign vacations, once restrictions are eased. Freight recovery will be closely linked to economic recovery and as yet there is too much uncertainty to forecast the shape of the curve.

We expect new habits to be formed, old habits to return but we hope that policy support will encourage all transport modes to grow more sustainable. **Zero-emission fuels and modal shifts will have to unite with solutions to reduce transport demand** (particularly for non-shared modes) and improve the efficiency of freight.

4.1. Public transport post-COVID

We expect to see a shift in how public transport systems are utilised in the coming months, given fears over public safety. In the short term, this could drive a **shift towards dirtier, personal car usage**, but as we will discuss below, for economic and policy reasons we believe this shift may be short-lived.

Taking China, where restrictions lifted earliest, as an example in cities where public transport was restricted, ridership is returning in some places, but not to full levels. According to a survey conducted by the Institute for Transportation and Development Policy in early March in the megacity of Guangzhou, only 34% of previous metro and bus commuters were using public transit systems, while 40% had shifted to private cars, taxis and ride-hailing, and the rest to walking and biking. In Hangzhou, the provincial capital of southeastern Zhejiang province, a survey at the end of March found the municipal bus system had recovered 50%-60% of regular ridership.¹¹³

Demand for public transportation has plummeted during the pandemic – by as much as 75-85% in cities such as Washington, Copenhagen, and Buenos Aires. Public transit app Moovit provides daily updates on public transit usage around the world and has tracked the sharp decline in usage across multiple countries. As at 15 May 2020, usage remained down 81% in Madrid, 79% in San Francisco, 77% in Rome and 72% in New York City. Even regions which are gradually emerging from lockdown are showing significantly decreased usage, such as Israel (50%).¹¹⁴

In the US, the Metropolitan Transportation Authority (MTA) predicts that only 60% of riders will return by the end of the year, even as city lockdowns ease.¹¹⁵ Many commuters will continue to work from home, sadly many workers may be laid off or furloughed, students may continue to take classes online and tourist numbers will likely remain depressed. Even those companies that are encouraging a physical return to work, such as the New York Stock Exchange, are banning workers from using public transport due to the risk of COVID-19.¹¹⁶ Will this drive a surge in personal car usage and a shift back to a “WILD” mobility model?

¹¹³ <https://thecityfix.com/blog/3-ways-chinas-transport-sector-working-recover-COVID-19-lockdowns/>.

¹¹⁴ https://moovitapp.com/insights/en/Moovit_Insights_Public_Transit_Index-countries.

¹¹⁵ <https://nyc.streetsblog.org/2020/05/15/the-coming-carmageddon-will-our-leaders-solve-nycs-transportation-problem/>.

¹¹⁶ https://www.wsj.com/articles/the-nyse-will-reopen-the-trading-floor-11589487300?mod=opinion_lead_pos8.

Many corporates, such as Twitter and Square, are moving entirely to a working-from-home model for all employees, and others, such as Facebook and Google, have announced that employees will not be required to return to work until next year.¹¹⁷ This will pressurise commercial rent but could help ease commute times for many, which average more than an hour in many cities globally. BNEF predicts that vehicle kilometres travelled will drop 15% in 2020 and not return to 2019 levels until 2022.¹¹⁸

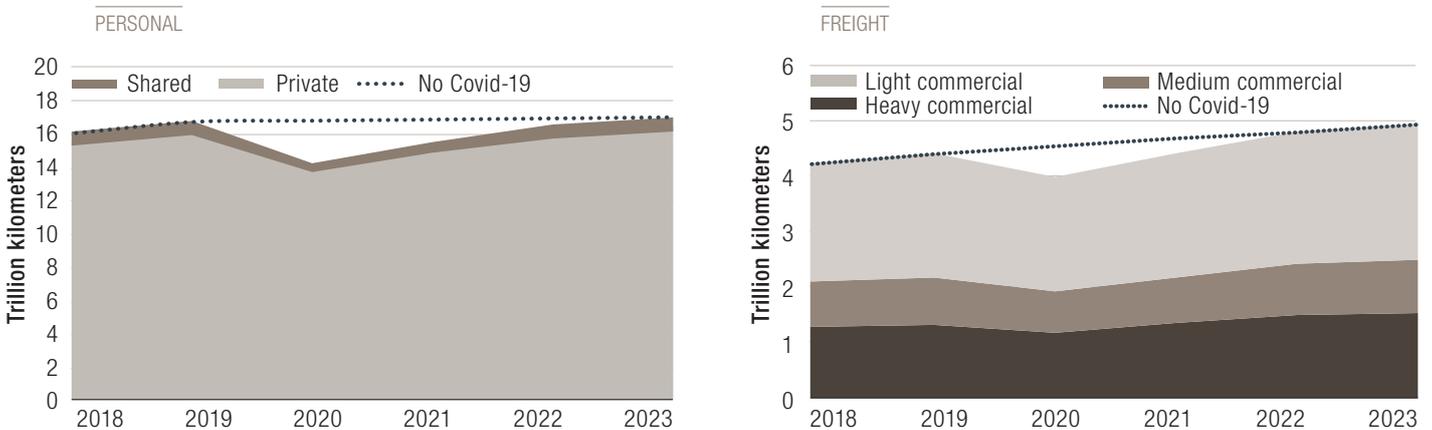
Many public transportation providers have adjusted the way they do business, even taking on new roles. Charlevoix County Transit (CCT) in northern Michigan is just one of many rural transit providers to begin home delivery of groceries, food pantry packages, and prescription medications to older adults and at-risk individuals.¹¹⁹ Many agencies have extended free fares to all riders and waived eligibility requirements for medical transportation services. MOVIA, the regional transportation authority for Copenhagen, and coordinator of innovative demand responsive flex services, has dedicated vehicles to transport COVID-19 patients from one hospital ward to the next.

Despite the **vital role that public transit plays in transporting goods and people**, and in reducing emissions (versus personal vehicle usage) declining ridership is now putting these systems at threat. The US Department of Transport has already offered

USD 1 billion to the National Railroad Passenger Corporation to support the railroad’s activities, given Amtrak’s ridership plummeted more than 90% during lockdown, forcing the rail operator to suspend operations on certain routes. The company also witnessed a sharp drop in future ticket purchases.¹²⁰ In May, **fifteen public transportation agency leaders in the U.S., which collectively serve communities who generate 35% of the nation’s GDP in the United States, have requested additional emergency federal aid for transit systems** during and after the coronavirus crisis. New York’s MTA estimates have suggested that **transit agencies nationwide will need an additional USD 32 billion to address the crisis** for the rest of 2020 and through 2021.¹²¹

As we will discuss in section 4.5 below, we expect for their survival, transit agencies will need to rethink their business models and work to manage social distancing requirements before encouraging commuters back. We believe policymakers will also step in to ensure the shift from public transport does not lead to “dirtier” forms of transport in its place. Outside of active mobility (walking, cycling) and micromobility (small electric 2 and 3-wheelers and micro-cars), public buses, rail and on-demand micro-transit remain the least emissions-intense form of personal transport.

FIG. 28 BNEF FORECASTS FOR PERSONAL AND FREIGHT KILOMETRES TRAVELLED



Source: Google opensource.

¹¹⁷ <https://www.nbcnews.com/tech/tech-news/following-twitter-square-also-let-employees-work-home-going-forward-n1209611>.

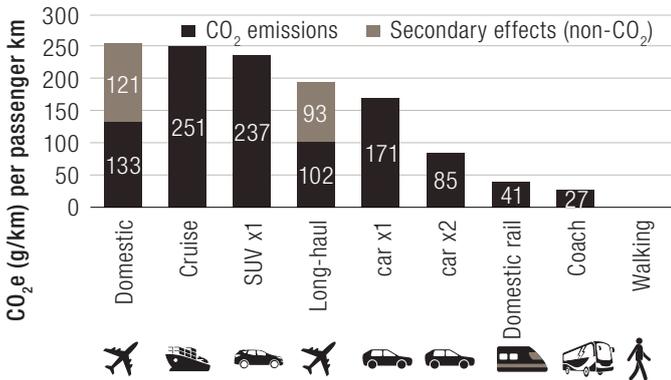
¹¹⁸ BNEF Electric Vehicles Outlook 2020, 19 May 2020.

¹¹⁹ <https://www.weforum.org/agenda/2020/04/public-transportation-provides-lifelines-during-COVID-19-heres-how/>.

¹²⁰ <https://www.railway-technology.com/news/COVID-19-impact-amtrak-funding/>.

¹²¹ Intelligent Transport, Major U.S. transportation leaders request further emergency federal aid, 10 May 2020. Accessed at: https://www.intelligenttransport.com/transport-news/98796/major-u-s-transportation-leaders-request-further-emergency-federal-aid/?utm_source=Email+marketing&utm_medium=email&utm_campaign=IT+-+Newsletter+19+-+14+May+2020&utm_term=How+is+t+he+public+transport+sector+coping+with+COVID-19%3f&utm_content=https%3a%2f%2femails.intelligenttransport.com%2frussellpublishinglz%2f&gator_tdf=4eou406ZIWcDR6SfgFeawKwoy1VbyvtVgOYDuCob57AYwb30UnWJGxlgNk36JxcWxPmPPjSe5AJmQhhbds%2fcORGYStzrphAqYi017UerhfhIbg394CNqdMia5B615TJg%2bM9qZ7Cb922baETfBUjpf0F1i2HPqMebgJISfYic%2bsDBq%2fCKwgceM7xYIWr9SU69uz53NLtbRWLVX5TybhZiQ%3d%3d.

FIG. 29 CO₂ EMISSIONS BY PERSONAL TRANSPORT MODE



Source: <https://www.bbc.co.uk/news/science-environment-49349566>; BEIS/Defra Greenhouse Gas.

4.2. Car usage post-COVID

As we will discuss in the following section, an increase in foot and bike traffic would be a bonus for air pollution but there is a risk that an **ongoing shift away from public transport** could also lead to a surge in personal car usage when lockdowns lift. In terms of CO₂ emissions (and congestion, safety, equality and air pollution) this would of course be a worst-case scenario. After walking, cycling and micromobility, public transport has a much better environmental footprint than a single-occupancy or even dual-occupancy car, or SUV (Figure 28).

And an increase in personal car usage also has implications for other sustainability challenges such as **human development** (with more and more people living in cities there isn't enough capacity to scale up car usage); **fair society** (cars aren't accessible to all and have health and safety implications); **dematerialisation** and **resource efficiency**. Traffic does not scale in a linear fashion. It compounds. Therefore a 10% increase in cars on the road does not lead to a 10% increase in congestion, but a much more significant increase and thus a more significant impact on air pollution, idling times and space devoted to the car. Building more roads does not ease congestion but rather induces more car usage. Therefore city planners are starting experimenting with new ways to discourage car usage (as we discuss below).

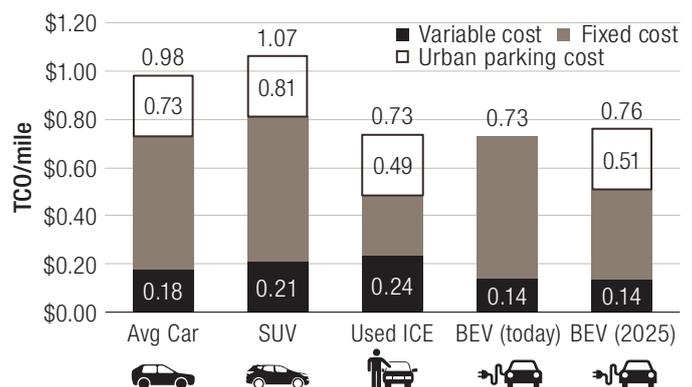
Greater congestion from personal car usage and ridehail comes in combination with a **drastic increase in urban delivery** vehicles (every second, 2,760 parcels are shipped globally¹²²) which are currently allowed to make multiple deliveries a day to a single household. This is putting even greater pressure on urban sustainability targets.

Of course a dramatic shift in working could have positive implications on urban transport usage (and health). However, if latest data from China is a sign of things to come in other cities as they exit lockdown, there has been a relatively fast recovery in car sales. The car market fell 80% in February, but in the first three weeks of March, declines moderated to 50%, 44% and 40% respectively, according to the China Passenger Car Association, with preliminary data showing nationwide sales for the whole of March were down only 36% from a year earlier.¹²³

However, one of the tragedies of the current crisis is the enormity of the ensuing impact on the global economy and in particular the consumer. With many millions of jobs at risk, pressure will grow on monthly spending patterns. While short-term mistrust of public transport may force some commuters to switch to personal cars, for many, the cost will prove prohibitive. While the variable cost of an owned vehicle is only USD 0.18/mile (falling as oil prices remain depressed), fixed costs such as urban parking, taxation, depreciation and insurance drive the average cost/mile to USD 0.98 (USD 0.73 ex-parking) for the average new car or USD 0.73 for a used car or electric vehicle.

This cost varies depending on mileage. The figures above are based on an average mileage of 11,000 miles/year. But **a car used for just a two-mile/day commute (730 miles/year) would cost USD 11/mile**. The same trip by public transport or micromobility would cost cUSD 2/mile or by ridehail cUSD 6/mile in the US. Of course on foot the trip would be free and a bicycle would only have the upfront purchase cost.

FIG. 30 TOTAL COST OF OWNERSHIP (TCO) OF DRIVING AN OWNED, PERSONAL CAR IN USD



Source: Lombard Odier, AAA, National Statistics, at Dec 2019 petrol prices. Note, we assume that current subsidised parking for EVs in many cities will be phased out by 2025.

¹²² Pitney Bowes Parcel Shipping Index (2019). Accessed at: <https://www.pitneybowes.com/content/dam/pitneybowes/us/en/shipping-index/pitney-bowes-parcel-shipping-index-infographic-2019.pdf>.

¹²³ <https://www.japantimes.co.jp/news/2020/04/09/business/car-boom-wuhan-lockdown-recovery/#.XsbEQJ2Sk2w>.

In the US, according to national statistics, 57% of households own two or more cars. This compares to 20-40% owning multiple cars in Europe. Many of these second or third cars drive very low mileages and might easily be foregone in favour of cheaper modes of transport, were household incomes to decline sharply, or more members of a household to work from home more regularly. If policymakers decide to put further pressure on car travel via **cost/mile road taxation** (see following section), some households might decide to jettison the car entirely. Around 20% of European households do not own a car at all (9% of US households) but these figures could rise. In **emerging markets** where car penetration is much lower, households could **leapfrog car ownership entirely** and shift to MaaS (mobility-as-a-service), once they are comfortable with social-distancing issues post-COVID, or because they cannot afford to own a car.

Could the dominance of the road in city centres be coming to an end? It certainly does not make sense that 70% of short journeys (<5 miles) are taken by car. We believe that given the likely staggered approach to lifting transport restrictions, combined with an increased trust in tele-working, daily commutes could remain reduced for months to come. Many more city policymakers may take this time as an opportunity to impose even greater restrictions on car usage.

4.3. Active and micro-mobility post-COVID – how to re-envision city space

Many countries globally have experienced strong growth in personal micromobility during the COVID-19 crisis. For instance the US has experienced triple digit growth in electric bike sales.¹²⁴ Many cities and micromobility operators are encouraging a return

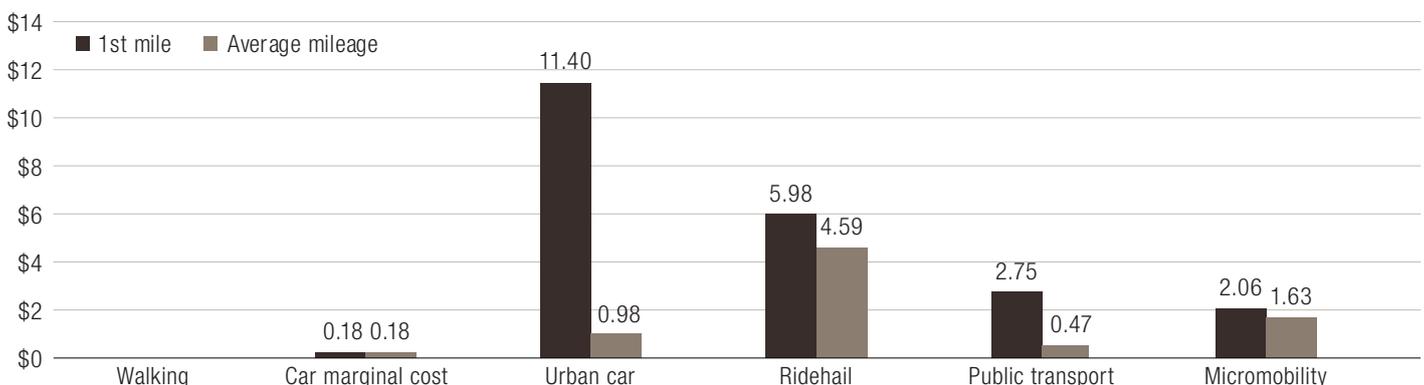
to more **active and micro-transport**. Some micromobility companies are using the crisis as an opportunity to expand service areas to help more people get around, especially on short trips. For instance, US-based shared, electric moped operator, Revel, made its service free for healthcare workers early in the crisis, and the city of New York then invited it to expand into Manhattan where it experienced strong demand for both free and paid rides, even while the lockdown is still in place.¹²⁵ Post-lockdown, many commuters are seeing similar vehicles as a safer alternative to public transport.

As China's economy re-opens, bike sharing appears to be returning to growth. According to Meituan and two other major bike-share companies, Hello-Bike and Didi Bike, ride volume in Beijing has increased 120-187%, compared to before the pandemic.¹²⁶ Local municipalities have encouraged this trend and taken steps to ensure bike sharing's accessibility and safety. For instance, the Beijing Municipal Commission of Transport banned bike-sharing companies from increasing prices during the pandemic.

It is unclear whether this surge in biking in China is just a temporary phenomenon. Data suggests that cyclists are riding longer distances directly to their final destinations, not just for first- and last-mile connections. Hello-Bike data¹²⁷ suggests long distance rides (more than 3 kilometers) have almost doubled compared to last year.

Similar trends are evident in other cities around the world. New York City's public bikeshare system, Citi Bike, saw a 67% surge in demand in early March compared with the same period last year. Chicago and Philadelphia saw ridership in their bikeshare

FIG. 31 COST/MILE BY TRANSPORT MODE AND TRAVEL DISTANCE



Source: Lombard Odier, AAA, National Statistics, at Dec 2019 petrol prices.

¹²⁴ <https://electrek.co/2020/05/20/post-COVID19-traffic-will-either-skyrocket-or-plummet-it-depends-on-us/>.

¹²⁵ <https://nyc.streetsblog.org/2020/03/26/revel-scooters-quietly-creates-new-manhattan-service-area/>.

¹²⁶ The City Fix (2020). 3 Ways China's Transport Sector Is Working to Recover from COVID-19 Lockdowns. Accessed at: <https://thecityfix.com/blog/3-ways-chinas-transport-sector-working-recover-covid-19-lockdowns/>.

¹²⁷ Idem.

programs nearly double during March. One of Philadelphia’s major bike trails experienced a 470% increase in traffic.¹²⁸

Many global cities are using lockdowns to lay the groundwork to keep **pedestrians and cyclists safe** and to encourage more transportation and a reallocation of the public right of way to facilitate safer walking and biking.

4.5. Will policymakers embrace these mobility shifts and actively encourage them?

While we expect commuter figures to remain depressed for a prolonged period as employers and employees re-think remote working practices, as lockdowns ease, more and more commuters will return to city centres. With population trends and **growing urbanisation** already pressurising space within cities, how will policymakers react to changes in mobility? It could be a once-in-a-lifetime opportunity to rethink our city space.

Public transport is in desperate need of support and in the US the recent CARES Act provides a USD 25 billion lifeline back to transit budgets and offers transit operators increased spending flexibility so that they are able to respond nimbly. In addition we expect Green Recovery funds to encourage electric vehicle adoption, boost charging infrastructure, spur investment in **hydrogen technology** and encourage a **more circular approach** to transportation usage;¹²⁹ we expect recovery packages to focus on opening cities up to **smaller modes of mobility**. We have already started to see this happen but we expect many of the temporary measures to become more permanent, with regulatory support.

In Paris, Mayor Anne Hidalgo asked her citizens to bike instead of drive during lockdown and continues to push her “city of 15 minutes” model for urban mobility, a policy also encouraged by Singapore where car usage is discouraged via high taxation. Paris has announced 403 miles of bike lanes to deal with post-lockdown traffic and is also accelerating her plan to remove parking spaces and make every street in the city bike-friendly.

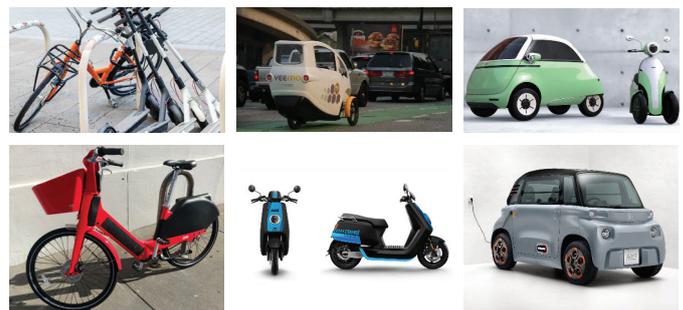
Other cities have announced similar plans to encourage more space in cities to be devoted to walking and cycling. Many of these measures are temporary in nature but some could become more permanent:

- In Milan, city leaders are lowering the speed limit to 20 miles per hour and changing the layout of 22 miles of streets to include widened sidewalks and temporary bike lanes.

- In Dublin, the city government removed parking spaces and loading bays to expand sidewalks, and installed bollards to protect the expanded sidewalk as well as existing bike lanes.
- In Edinburgh, the city government is expected to shut down some roads to widen pedestrian walkways and install bus lanes to promote more active travel.
- Seattle’s program, which opened 20 miles of streets to bicycles, has been so successful that officials are going to make the change permanent when the pandemic is over.
- Similar measures are being discussed in London to ban cars from certain roads and create the largest “car free zone” of any city in Europe, lower speed limits and widen pavements to enable safer foot and cycle trips.
- The UK government introduced a new GBP 2 billion multi-year cycling and walking funding package.¹³⁰ E-scooter trials will be brought forward from 2021 to June 2020 to help encourage more people off public transport and onto greener alternatives. Pop-up bike lanes with protected space for cycling, wider pavements, safer junctions, and cycle and bus-only corridors will be created in England as part of a GBP 250 million emergency active travel fund – the first stage of the GBP 2 billion investment, and part of GBP 5 billion in new funding announced for cycling and buses in February.¹³¹

Congestion charging, localised car bans (such as in Oslo city centre) and removal of city parking spaces are all means that urban planners are using to divert city space from the car (10 shared scooters or bicycles could fit into the space of one car).

FIG. 32 A SMALLER VEHICLE THAN A CAR COULD SUFFICE FOR MANY SHORT, URBAN JOURNEYS



Source: Barclays Research, VeloMetro, Microlino, Citroen and Revel (all used with permission).

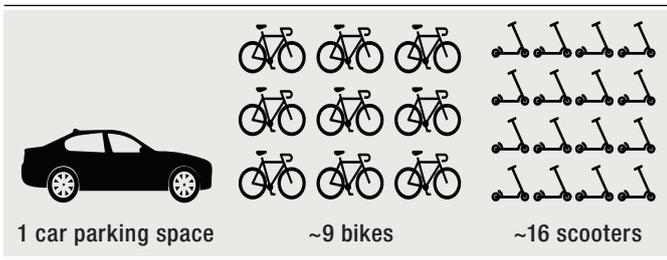
¹²⁸ <https://www.wri.org/blog/2020/04/coronavirus-biking-critical-in-cities>.

¹²⁹ As per the EU proposed Green Deal accessed at https://ec.europa.eu/info/strategy/eu-budget/eu-long-term-budget/2021-2027_en.

¹³⁰ https://www.intelligenttransport.com/transport-news/98777/uk-e-scooter-trials-to-be-fast-tracked-as-part-of-sustainable-transport-boost/?utm_source=Email+marketing&utm_medium=email&utm_campaign=IT+-+Newsletter+19+-+14+May+2020&utm_term=How+is+the+public+transport+sector+coping+with+COVID-19%3f&utm_content=https%3a%2f%2femails.intelligenttransport.com%2frussellpublishinglz%2f&gator_tdf=4eou406ZIWcDR6SfgFeawKwoy1VbyvtVgOYDUcOb57AYwb30UnWJGnxlgnK36JxcWxPmPPjSe5AJmQhbd%2fc0RGYStzrphAqYi017Uerhfhlg394CNqdMia5B615TJg%2bM9qZ7Cb922baETfBUjpoF1i2HPqMebgJISfYic%2bsDBq%2fCkkgceM7xYIWr9SU69uz53NLtbRWLVX5TybhZiQ%3d%3d.

¹³¹ <https://www.gov.uk/government/news/major-boost-for-bus-services-as-pm-outlines-new-vision-for-local-transport>.

FIG. 33 SINGLE-OCCUPANCY CARS ARE NOT THE MOST EFFICIENT USE OF URBAN SPACE



Source: LOIM, ICCT. For illustrative purposes only.

We expect to also see **more regulation on freight transport**, particularly within urban spaces. At present, a single household could receive multiple deliveries in one day, from a number of freight service providers. As town planners seek to reduce congestion and air pollution, this may change. We may see increased “zonification” of cities through the construction of consolidation centres around cities. A freight company might be limited to a certain zone, which would reduce the number of vehicles, without compromising the number of parcels that can be delivered.

Legislation will likely be required to reduce the emission impact of this rapidly growing logistics segment. There needs to be much more **bundling of deliveries** and returns collection across e-commerce operators, more control of delivery methods and slots, and the imposition of higher vehicle standards and associated driver training. We believe this is likely to start at the city level, but spread to national legislation. As technology advances, many of these efficiencies can be achieved at the touch of a button.

4.6. Technology is a key enabler of more sustainable transport

Policy will provide a push but technology should increasingly drive innovation in sustainable transport post-COVID. Chinese cities have adopted data-driven tracking and scheduling systems. In Suzhou, a smart transit platform analyses crowd distribution inside buses in near-real time and identifies the volume of passengers in each vehicle through smart transit cards. The system proved helpful during the COVID-19 outbreak, when the vehicle occupancy information was made available to the public to allow the staggering of travel time and is now helping the city monitor a slow return to normal. **Technology continues to be a key enabler**, with many Chinese transit systems encouraging people to use traceable payment methods like WeChat, Alipay or transit smart cards, instead

of cash. These payment methods not only cut down on exposure risks, but also help local authorities trace possible contacts.

The “Alipay health code” system was initiated in many cities whereby citizens were given a personal QR code that traced their travel log between cities and categorized them into different safety levels that dictate whether a person is allowed on the subway/needs quarantine etc. Of course, with increased digitalisation comes data privacy concerns (which differ geographically). We see technology as a great enabler of the Transport Revolution as long as it is developed with data privacy and fair society concerns to the fore.¹³²

Globally many companies are preparing for similar changes – by offering greater access to travel statistics to enable consumers and policymakers to make better mobility decisions and manage shifting demand. Technology will enable greater understanding of transport patterns – for instance Apple has made mobility data available to aid COVID-19 decision making. **More connected transport apps** will also offer commuters greater choice over transport mode, particularly for first and last-mile journeys. In our view, this is likely to drive a greater uptake of **MaaS** (mobility as a service) as more commuters prefer flexibility of transport mode and the ability to share journeys via micro-transit rather than public transit. More efficient logistics, particularly for last- and first-mile deliveries, will also be enabled by a greater use of technology.

4.7. Economic impact of COVID-19 to weigh on transport demand

The coronavirus-induced worldwide financial crisis will also be a key factor in keeping travellers close to home, at least in the short term. The economic impact of coronavirus will leave many people with less money to do non-essential travel.¹³³

There could be significant shifts to long-haul transport post-COVID-19. A recent survey by Barclays in the UK¹³⁴ found that 40% of business travellers say they will reduce the number of flights they take, while only 26% of leisure travellers are likely to do the same once lockdowns ease. The decision to book new leisure trips will be driven by when travellers feel safe, with 56% of respondents citing this as one of the driving forces behind confidence in booking trips and 27% waiting for a vaccine. After safety concerns, intra-modal shifts and purchasing power pressures score highly as reasons to reduce travel, and despite flight-shaming being a popular trend pre-COVID,¹³⁵ only 13% cite the environmental impact of aviation as the driving force. Business travel may also be severely curtailed as corporates discover the convenience and cost-effectiveness of virtual conferencing.

¹³² <https://www.nytimes.com/2020/03/01/business/china-coronavirus-surveillance.html>.

¹³³ <https://www.vox.com/coronavirus-COVID19/2020/4/2/21201905/coronavirus-economic-crisis-recession-depression-stimulus-checks-COVID-19>.

¹³⁴ Barclays Research, Travel survey: 12-17% of business trips at risk of being substituted, 21 May 2020.

¹³⁵ The number of passengers that flew through Swedish airports dropped 4% in 2019 and in December, domestic travel fell by 7% and overall traffic was down 4%, which has been ascribed to the “flight shaming” movement: <https://www.reuters.com/article/us-airlines-sweden/swedens-air-travel-drops-in-year-when-flight-shaming-took-off-idUSKBN1Z90UI>.

BNEF¹²⁷ forecasts that vehicle miles travelled in 2020 could fall 15% in 2020 and remain depressed into 2021 and not recover until 2023. It expects the movement of goods – particular urban delivery – to hold up better and forecasts freight ton kilometres falling only 10% and recovering to 2019 levels by 2022 (see Figure 27).

For air cargo the World Trade Organization forecasts a 13% fall in trade in 2020 in an optimistic scenario and a 32% fall in pessimistic scenario.¹²⁸

But we hope the knock-on economic impact of COVID-19 on long-haul transport will not prevent policymakers stipulating greener practices into any recovery packages. The International Air Transport Association (IATA) is asking for a near-term relaxation of proposed CO₂ regulation on the aviation industry, as a result of the sharp drop in demand during the crisis, but net-zero targets are enshrined in law for many countries and will require a concerted effort to reduce emissions from long-haul transport as much as from short-haul. Shipping and freight transport will also remain in the spotlight, due to the carbon-intensity of current methods.

¹²⁶ Bloomberg New Energy Finance, Long-term Electric Vehicles Outlook, 19 May 2020.

¹²⁷ https://www.wto.org/english/news_e/pres20_e/pr855_e.htm.

5. Conclusion

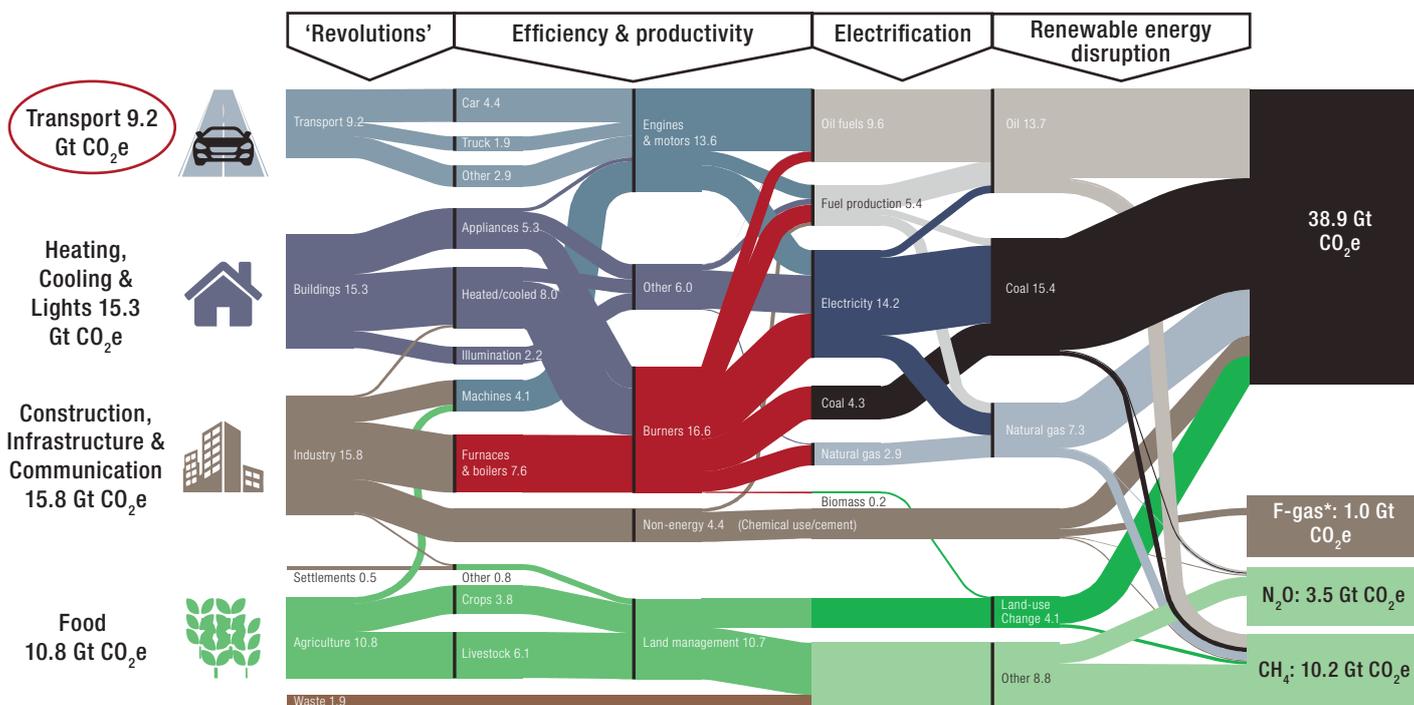
We see the devastating effects of the current crisis as having long-term implications for all modes of transport and travel. Business-as-usual may return in some areas in the coming months but we suspect a shift in many types, lengths and frequency of trips will linger. This could provide a much-needed opportunity to reduce emissions from transport, which is one of the only sectors in the EU and the US where emissions continue to rise. But we expect it will only be with a more drastic policy-push that transport will be set on a net-zero trajectory, a trajectory which requires GHG emissions to fall 7.6% annually in the next decade (as much as the IEA projects CO₂ may fall in 2020 due to COVID-19 lockdowns).

As a new normal emerges once travel restrictions are eased, we expect commuters to rethink prior daily commutes and long-distance business travel. We expect commuter figures to remain depressed for a prolonged period as employers and employees stick to more regular remote working practices. But as lockdowns ease, many commuters will be forced to return to city centres. With population trends and growing urbanisation already pressurising space within cities, we need policymakers to react to enforce changes in mobility. It could be a once-in-a-

lifetime opportunity to **rethink our city space** but also how goods and people are transported over longer distances too. In cities, commercial property space may come under threat, and retail too, and **combustion engine car sales may reach peak** sooner than forecast. We expect to see temporary bicycle lanes and pedestrianised roads made permanent fixtures and expect a **surge in active and micro forms of mobility**. Air travel demand may never return to peak levels, but a switch to more sustainable long-distance transport modes (such as zero-emission rail) could be the result.

Many of these changes will ease pressures from growing urbanisation trends, and other sustainability challenges such as dematerialisation, resource efficiency, zero-emissions and fair society. **Digitalisation will be a key enabler** of the revolution as cleaner technologies (such as EVs and hydrogen) become cheaper and offer increasing efficiencies for the movement of people and goods. Mobility is vital for future economic development and recovery and in our view can offer a **USD 2 trillion annual opportunity** to investors. But this mobility needs to be equitable, accessible, resilient cost-effective and clean.

FIG. 34 THE COMPLEX GLOBAL FLOW OF GHG EMISSIONS SHOW HOW INTRINSICALLY LINKED TRANSPORT IS IN THIS INTRICATE WEB



Source: LOIM analysis. Resource efficiency collection, Leonardo DiCaprio Foundation, (2014). *Fluorescent Gas. For illustrative purposes only.

At Lombard Odier, we have sustainability as a core conviction and believe the sustainability of transport is a cross-cutting theme across multiple industries and sustainability challenges. We believe a transport revolution is underway to untangle the complex web of emissions from economic development.

It will require concerted action from policymakers, corporates and consumers to enforce the change. We believe this will not only **benefit the Climate Transition** but will also stimulate **economic growth** and **more sustainable health, which will ultimately benefit investors**.

At Lombard Odier we see at least USD 2 trillion annual investment opportunity as a result of this transition to a Circular, Lean, Inclusive and Clean (CLIC) mobility model. We see the post-COVID Transport Revolution offering opportunities across Technology, IoV, Infrastructure, Mobile

Payments, Green Buildings, MaaS, biofuels, hydrogen, the electric vehicle supply chain and emerging, cleaner transport modes such as micromobility. We also see risks for some incumbent business models such as car ownership, combustion engines, air travel and oil demand.

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